Developing a Taxonomic Framework for Creativity in a Problem-Solving Context:

A Research in the Higher Education Context

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ABSTRACT

Creativity has been recognised as one of the most important skills in the 21st century. Although creativity has been advocated in the context of education, there still seems to be a lack of understanding of the concept of creativity, leading to teaching and learning practices that still encourage uniformity and conformity. The current literature on creativity is insufficient for understanding creativity from a more comprehensive manner, as frameworks and taxonomies for creativity largely focus on either listing a set of components relevant to creativity without explaining strategies that invoke creativity or categorising creative strategies without explaining the factors that support the use of these strategies, and the result of applying these strategies. More importantly, these frameworks are largely theoretical without empirical evidence. While there have been studies that investigate approaches for developing creativity, the effectiveness of these approaches is measured based on the improvement demonstrated through the creative outputs produced by the participants, by mainly looking at the number of solutions being produced and the originality of the solutions. They do not examine the use of strategies in the creative processes. As such, the understanding of how creativity can be supported by the use of set of strategies remains insufficient. In view of these situations, this study aimed to develop a taxonomic framework that could facilitate the understanding and development of creativity, which could serve as a foundation for teaching, learning and assessment. This study viewed creativity from the problem-solving perspective, where problems act as a catalyst for creative thinking.

The sample for this study was lecturers and students across various disciplines from an international university in Malaysia. This study aimed at (i) developing a prototype taxonomic framework for creativity through a synthesis of literature on theories, frameworks and research on creativity, (ii) exploring and understanding the meaning of creativity from the higher education lecturers and students' perspectives, (iii) examining the creativity features and usability of the taxonomic framework based on the perceptions of creativity and the relevance of the framework among a group of higher education lecturers and students, and (iv) examining the use of the creative strategies in the prototype taxonomic framework for creativity through a problem-solving task. The methodology for this study involved a mixed-methods, multiphase design. This study comprised four phases i.e., (i) a systematic synthesis of the literature on creativity through a thematic analysis to develop a prototype taxonomic framework for creativity, (ii) data collection from general higher education lecturers and students through a survey, (iii) data collection from the participant-nominated creative students and lecturers through a series of interviews, and (iv) data collection from higher education students through a problem-solving task. Findings revealed that the prototype taxonomic framework for creativity consisted of 24 features of creativity. Findings gained from the survey and interviews showed that creativity was generally perceived as an ability related to the mental processes and the ability to produce something that has a value – usually innovativeness and originality. Additionally, the taxonomic framework was generally perceived to be relevant for teaching, learning and assessment. Findings from the problem-solving task revealed that the taxonomic framework was able to facilitate creativity, by allowing students to use a wider range of strategies, produce more solutions, provide greater detail to their solutions and generate solutions that are novel, useful and ethical. In general, the overall findings from the study have demonstrated that creativity is a skill that can be taught and learned. The implications of the study offered several contributions of the framework for educational purposes.

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CAT: Consensual Assessment Technique

ZPD: Zone of Proximal Development

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CHAPTER ONE

INTRODUCTION

Creativity is just connecting things. When you ask creative people how they did something, they feel guilty because they didn't do it, they just saw something. It seemed obvious to them after a while.

Steve Jobs

Think left, and think right and think low and think high. Oh, the thinks you can think up if only you tried.

Dr. Seuss

1.1 Introduction

"To create" has generally been associated with actions such as "to grow", "to make", "to bring forth," or "to produce." Early and contemporary studies revealed that creativity has been seen as an act or ability to be original (Jackson & Shaw, 2006; Torrance, 1962) and to innovate by forming unorthodox relationships between seemingly unconnected ideas, pieces of knowledge and skills (Boden, 2004; Mednick, 1963). Creativity has also been perceived as producing something useful or appropriate (Amabile, 1982; Boden, 2004) particularly when there is a need for solving a problem (Amabile et al., 2012; Sternberg & Lubart, 1991). It has been shown as an ability influenced by the individual's personality (e.g., Batey et al., 2010; Kaufman, 2012; Liu et al., 2016), emotions (e.g., Csikszentmihalyi, 1990; Delgado, 2017; Dörfler & Eden, 2014), cognition (e.g., Chiu, 2014; Guilford, 1950; Wang et al., 2016; Xing & Chen, 2009) and their contextual situations (e.g., Fjaellingsdal et al., 2021; Rock, 2008).

In the literature, the controversy of whether creativity is an inherited, spontaneous trait or a learnable skill has always existed. Creativity has been long perceived as an ability that people inherit (Galton, 1869, cited in Glăveanu, 2010; Diakidoy & Kanari, 1999; Kampylis et al., 2009), a skill mainly associated with the arts domain (Kampylis et al., 2009; Newton &

Beverton, 2012), and a result of a sudden realisation (Wallas, 1926; Mullet, 2016). Creativity today is also considered as an ability that everyone can possess (Henriksen & Mishra, 2015) as it can be influenced by the environment (Amabile, 2012). Creativity can also be nurtured and taught (Beghetto, 2017; Dumas et al., 2016; Maksic & Spasenovic, 2018; Sternberg, 2010), or can be an outcome of a collective effort (Kenny, 2014). Therefore, any study of creativity needs to consider these questions: are creative acts and abilities genetically bestowed on a selected few whose ideas and creations have shaped the lives of the masses throughout history (Boden, 2004; Kaufman & Beghetto, 2009)? Is creativity about rearranging, reconnecting and amalgamating multiple interdisciplinary concepts and ideas (Benedek et al., 2021)? Is it a myth to claim that only a few are really gifted with the ability to be creative (Tomasevic & Trivic, 2014; Weisberg, 1986)? Is creativity only related to special fields like the arts (Myhill & Wilson, 2013)? Or, that creativity can only be achieved by coming up with ideas in unstructured ways through “eureka” moments of inspiration (Mullet et al., 2016; Wallas, 1926)?

Creativity has now been generally recognised as a teachable and learnable skill (e.g., Maksic & Spasenovic, 2018; Sternberg, 2010); therefore, it is possible to teach individuals to exercise creativity particularly in problem solving (e.g., Dumas et al., 2016; Ulger, 2018). Prior to the 21st century, creativity had been associated as a foundation for problem solving (Puccio, 2017). In the 21st century, creativity today gained recognition as one of the essential skills for individual and societal progress (Rubenstein et al., 2013), to cope with crisis (Tang et al., 2021) and to achieve healthy social wellbeing (Orkibi & Ram-Vlasov, 2019; Tang et al., 2021). In the field of education, although there is a growing belief that creativity is teachable and learnable (e.g., Maksic & Spasenovic, 2018; Sternberg, 2010), the conventional perceptions that it is an innate talent (Katz-Buonincontro et al., 2020), a skill that resides predominantly in the arts (Kampylis et al., 2009; Newton & Beverton, 2012), and a sudden insight as a result of the “aha” moment (Mullet et al., 2016), still persist. Educators who persist on these conventional perceptions could be encouraging uniformity in students’ responses through overly emphasising rote learning (Ehtiyar & Baser, 2019). Should creativity be viewed as inherited, educators may not recognise the personal, new interpretations constructed by students, and further nurture the development of higher levels of knowledge construction through creativity (Runco, 2004). If creativity is perceived as synonymous with the arts, creative thinking may not be incorporated into other subject matters. If creativity is seen as merely an unexplainable sudden moment of realisation, there may not be attempts in teaching students strategies that instill creative thinking. These beliefs and ethos may ultimately inhibit creative behaviours. Educators therefore need to possess a mindset to believe in the presence of creative capacity in every student.

Although the democratic view of creativity has argued that creativity is an ability that can be taught and learned by a carefully planned methodology that includes the process of developing the skills of creativity (Beghetto, 2017; Jeffrey & Craft, 2004), the literature in creativity does not seem to sufficiently support the teaching and learning of creativity. My study posited the same view that creativity can be acquired and learned, and therefore should be accessible to everyone, especially students. However, the understanding of creativity as a teachable skill is mainly guided by models or frameworks on creativity (e.g., Amabile, 1982; Runco & Chand, 1995) that only entail the components relevant to creativity (e.g., domain knowledge, motivation) without providing concrete strategies to exercise creative thinking. A few frameworks that categorise creative actions (e.g., Eberle, 1971; Nilsson, 2011) do not take into consideration factors that support these creative actions; they are also largely theoretical that lack empirical evidence, especially the qualitative dimension to assist in understanding the "how" and "why" creative behaviour operates. In view of these gaps, this study identified and organised features that characterise creative acts and abilities into a set of creative strategies. These strategies were then incorporated into a taxonomic framework that assisted in understanding and developing creativity in higher education. After that, the study assessed the relevance of the taxonomic framework through reviews from lecturers and students from a higher education context, and explored the application of the taxonomic framework through a problem-solving task with higher education students.

This introductory chapter presents an overview of the study. It starts with background of study followed by the problem statement. The chapter then outlines the aims and research questions, context of the study and significance of the study. It ends with an explanation of the structure of the thesis.

1.2 Background of the Study

This section discusses the need for advocating and developing creativity in education. I begin the discussion by explaining how creativity is involved and relevant in problem solving, followed by a discussion of the way in which creativity has been advocated in teaching and learning.

1.2.1 Problems as a catalyst for creativity

This study argued that problems are a primary catalyst that generates a need for creativity. Concurrently, creativity enhances the process of solution generation in the problem-solving process (Duncker, 1945; Mayer 1992, 2013). While some researchers indicate that defining a problem is difficult because the concept of “problem” itself is vague (Garlick & Thompson, 1997; Mumford et al., 1991), problems have also been defined as a situation where there is an awareness of the need for carrying out an action, but that action cannot be immediately carried out to fulfill the need (Ernest, 1991). Similar to this view, this study defines that a problem occurs when a person has a goal but does not have a clear path to achieve it (Duncker, 1945). A problem can take various forms, such as an unexplained phenomenon, the need for improvement, the need for new ways of doing things, the need for immediate attention and failure to accomplish something (Tan et al., 2009). Regardless of the forms a problem manifests in, this problem will then lead to the search for alternatives to resolve the situation (Duncker, 1945).

In real life, a problem may be addressed in many equivalent ways or has no solutions. Additionally, even when a solution is found, there may be no way to determine that it is a correct or optimal solution (Garlick & Thompson, 1997). For example, in attempting to quickly curb the spread of Covid-19, different countries have resorted to different solutions. Some countries, such as China, imposed a full lockdown which shuts down all economy and social activities, including closure of buildings or geographical area. Other countries, such as Taiwan and Malaysia, implement covid-19 regulations that vary in degrees in people movements, social gatherings, entry for international travel, and quarantine requirements. The measures involved in implementing a full lockdown, introducing new covid-19 regulations, or other means were not fixed and changed according to the development of the Covid-19 situation and the readiness for possible risks. Although some of these measures have been proven effective, thus far, none of these measures has been declared as the only or most optimal solution in curbing the infection. Guilford (1967) proposes that real problem solving involves actively seeking, constructing new ideas that fit with constraints imposed by a task or by the environment. Therefore in most instances, “real” problem solving involves critical analysis and creative thinking of the problem and solutions (Mayer, 1983).

The way in which a problem stimulates creativity may be reflected in three classic views of problem solving, Associationist, Gestalt and information-processing perspectives. According to the associationist view, problem-solving is a process of associating the problem with past experiences, particularly previous successful experiences, to address the problem (Thorndike, 1911, cited in Mayer, 2013). Associationists argue that creativity is not about creating something entirely new, but the ability to apply appropriate ideas or solutions, including past successful ideas or solutions to solve existing problems (Mayer, 1992).

However, if problem solving is about making use of previously successful solutions to address a problem, the Associationist view has not explained how individuals solve a problem that has never been encountered before or has no association at all with past experiences.

The Gestalt's perspective addresses the limitations of the Associationist perspective by viewing problem-solving as a process of making breakthroughs in preconceived notions or ideas to generate novel solutions (Duncker, 1945; Mayer, 1992, 2013; Weisberg & Alba, 1981). To do so, mental blocks need to be eliminated when a problem cannot be solved in conventional ways. Once these mental blocks are overcome, usually abruptly and unexpectedly, the problem will be resolved. This sudden moment when a fixed, conventional perception is overcome is called "insight" or the "aha" moment. Thus, the "insight" appears abruptly and unexpectedly. Creativity is a matter of an "aha" moment in a problem-solving process that cannot be explained. A question to be raised here is therefore whether there is a means to achieve the "aha" moment given that it is described as unexpected.

The information processing view offers an explanation to understand creativity in problem solving through a systematic mental process that requires careful understanding of the problem and use of possible strategies to address the problem (Mayer 1992, 2013). Thus, creative solutions can be achieved in a predictable manner. However, this approach seems more applicable to well-defined situations where there is a clear and achievable goal, a standard solution, and a clear solution path or operation (Mayer, 2013). However, the information processing view neither specifies ways to understand a problem nor types of mental processes required to solve a problem creatively.

Although studies have shown that a problem can be a catalyst for creativity (Fleck & Weisberg, 2004; Osborn, 1953; Thorndike, 1911, cited in Mayer, 2013), the three views of creativity have not explained how previous solutions and experiences can be used to solve a novel problem (Associationist view), how novel solutions can be generated through breaking conventional notions (Gestalt's view), and how systematic procedures can be applied in solving a new, ill-defined problem (information processing view). In view of the lack of clarity in these views, there is a need to understand the creative problem-solving process, particularly strategies that individuals use to generate solutions.

1.2.2 Education reform to meet the 21st century needs

Creativity has been identified as an essential skill in education by several contemporary reports and frameworks, including the Framework for 21st Century Learning (Partnership for 21st Century Skills, 2009) and OECD reports (e.g., OECD, 2018). The demand for creativity in recent years has increased tremendously, given rapid globalisation and technological advancement to address current social, economic, and environmental challenges (OECD, 2018). It is also predicted that by 2030, over two billion jobs will disappear globally (Frey, 2012). Soft skills such as creativity are deemed more valuable than academic content knowledge in the age of wide access to information (Partnership for 21st Century Skills, 2009; OECD, 2018). As a result, educational reforms are largely underpinned by the philosophy and concepts of creativity such as incorporating problem-solving curricula (Orozco & Yangco, 2016; Ulger, 2018) and design-based learning (Atlan & Tan, 2020; Henriksen et al., 2017).

In the field of education, there are three interrelated dimensions of creative teaching that are often discussed: teaching creatively, (Beghetto, 2017; NACCCE, 1999), teaching for creativity (Beghetto, 2017; NACCCE, 1999), and teaching about creativity (Beghetto, 2017). Teaching creatively is aimed at teaching any subjects through an innovative approach to achieve the intended learning outcomes (NACCCE, 1999). It stimulates motivation in learning and creates a fun environment for learning (Liao et al., 2018). Teaching for creativity is aimed at nurturing and cultivating creative thinking, attitude and behaviour in students (Beghetto, 2017; NACCCE, 1999). Teaching for creativity develops students' creativity through learning experiences that focus on nurturing creativity (Hulse & Owens, 2019). Teaching about creativity is aimed at increasing knowledge and awareness about creativity, including cognitive skills, emotions, and contextual factors that are related to creativity (Plucker & Dow, 2010). Explicit teaching of creativity concepts has been shown to enhance students' beliefs about creativity (Plucker & Dow, 2010). However, Beghetto (2017) cautioned that knowing one dimension of creative teaching does not automatically lead to success in the other dimensions of creative teaching. Therefore, educators need to be clear of the pedagogical aims of each dimension of creative teaching. They will need to be supported and provided with trainings and guidance to implement effective creative teaching.

Based on the arguments above, it may be inferred that the success for teaching and learning creativity requires a parallel emphasis on the three forms of creative teaching. As problem solving has been a common teaching approach in higher education (e.g., Orozco & Yangco, 2016; Ulger, 2018), these three forms of creativity could be applied to teach creative problem solving in the context of higher education. To teach about creativity, there needs to be a focus for students to learn about concepts of creativity and apply these concepts in different contexts. To teach for creativity and to teach creatively, educators need to understand creativity and how creativity can be embedded and demonstrated in the process of teaching and learning. Although these three forms of creative teaching are equally important, educators may not necessarily be aware of and know how to implement all three forms of creative teaching. As educators are the agent of change in education (Heijden et al., 2014), they need to be equipped with guidance to understand creativity and strategies to nurture and develop creativity. Thus, there needs to be a set of creative strategies to facilitate educators' understanding of creativity, planning of learning outcomes and setting up conducive environments for creativity.

1.3 Statement of the Problem

1.3.1 Problems in Creativity in Higher Education

In higher education, creativity is significant for learners for a number of reasons. Firstly, being equipped with creativity increases employability. Creativity has been proposed as a drive for encouraging enterprise (Serrat, 2017) and recognised as a resource for promoting well-being at the workplace (Helzer & Kim, 2019). It is a skill for lifelong learning to promote social integration, personal development, self-sufficiency and competitiveness in the labour market (Pozilova et al., 2020). Secondly, Csikszentmihalyi (2006) stressed that "it takes creativity not to be blinded by the trappings of stability, recognise the coming changes, anticipate their consequences, and thus perhaps lead them (the changes) in a desirable direction" (p. 18). It is therefore argued that teaching creativity in higher education not only requires students to find solutions to the problems that they face but exposes students to unpredictability, encourages them to accept and anticipate changes, and predict the consequences of their actions. Thirdly, creativity is a key prerequisite for academic research as it drives scholars to ask new questions and find innovative answers to contemporary issues or problems (Baptista et al, 2015; Brodin, 2016; Wisker, 2015; Wisker & Robinson, 2014). Given the importance of creativity, higher education institutions have incorporated and increased their emphasis on creativity through curriculum and policy revisions (e.g., University of Oxford, 2015; The University of Queensland Australia, 2016) as well as teaching and learning (Gaspar & Mabic, 2015; University of Oxford, 2015). Although the importance of creativity in higher education is highly recognised, thus far, studies on creativity in higher education has been scarce. The focus seems to be predominantly on examining lecturers' and students' beliefs about creativity (e.g., Gaspar & Mabic, 2015; Kleiman, 2008). Less attention has been given to examining ways to develop creativity in higher education.

Another problem of creativity in higher education is the greater emphasis placed on promoting criticality over creativity (Puccio & Lohiser, 2020). Creativity has been claimed to be the stepping stone towards developing other skills such as criticality (Ahmadi & Besancon, 2017). While critical thinking is defined as analysing, evaluating or synthesising information and applying knowledge to form logical and reasonable arguments, draw conclusions, or make decisions based on relevant evidence (Glaser, 1941; Mandernach, 2006), creative thinking involves being imaginative, thinking unconventionally to produce ideas that are novel and useful. Critical thinking vs. creative thinking is thus a contrast of "analytic vs. generative", "linear vs. associate", "convergent vs. divergent" and "reasoning vs. novelty" respectively. Critical thinking and creative thinking can be seen as being in a symbiotic relationship with one another – critical thinking ensures novel ideas or solutions contain appropriate and functional values to address a problem; creativity enriches the quality of solutions by coming up with ideas or solutions to new problems that did not exist before. Higher education, therefore, is not only about churning out graduates who are constantly evaluating solutions that already exists (i.e., criticality), but also proposing and producing solutions that have not yet existed to solve unexpected, unprecedented problems (i.e., creativity). While critical thinking is seen as a main skill in higher education (Arend, 2009; Jackson, 2008), creativity in higher education seems to be seen as omnipresent, as it is "taken for granted and subsumed within analytic ways of thinking that dominates the intellectual territory" (Jackson, 2008, p. 7). If creative thinking continues to be assumed as a part of critical thinking, students may then be denied the opportunities to acquire and master this competency through a range of creativity development strategies.

Moreover, in higher education, teaching in higher education still values uniformity and conformity to completing tasks, thus there is a lack of space that encourages and nurtures creative attempts (Ehtiyar & Baser, 2019; Gaspar & Mabic, 2015). Lecturers are found to lack understanding about creativity and approaches to teaching and assessing creativity (Ehtiyar & Baser, 2019; Hong & Kang, 2010; Jackson, 2008). This may explain the lack of alignment between promoting creativity and the curriculum in terms of learning outcomes, learning plans and assessment for creativity (Daly et al., 2014; Wiggins & McTighe, 2005). As creativity is argued to be an ability that can be nurtured through strategic teaching, if one does not understand how creativity can be applied in education, they will not be able to implement creative pedagogy (Patson et al., 2018) that teach about, teach for and teach with creativity. As educators have expressed the lack of training and skill development in the area of creativity as a barrier to being creative in teaching (Cheung, 2012; Cremin et al., 2015; Kampylis et al., 2009), this study recognised the need for constructing a taxonomic framework for creativity that could assist in understanding and developing creativity in higher education through the use of a set of creative strategies.

1.3.2 Problems in Existing Creativity Frameworks and Taxonomies

Existing frameworks and taxonomies for creativity usually focus on one dimension of creativity i.e., either the factors contributing to creativity, or the steps or creative actions leading to creativity. For instance, some frameworks (e.g., Amabile, 1982; Runco & Chand, 1995) categorise the social (e.g., work environments, rewards) and psychological factors (e.g., motivation) necessary for an individual to produce creative work without explaining the strategies involved in creativity. Similarly, frameworks and taxonomies that attempt to delineates a series of steps (e.g., defining a problem, generating solutions, evaluating solutions) and classify creative actions (e.g., Eberle, 1971; Nilsson, 2011; Stahl, 1981) involved in creative problem solving (e.g., Isaksen & Treffinger, 2004) do not explain factors that could facilitate these actions and the outcomes of these actions could be. Consequently, these frameworks may imply that creativity is merely a series of cognitive processes that occur in a vacuum. More importantly, they are largely theoretical that lack empirical evidence. Furthermore, these frameworks do not provide a way to describe and differentiate creative behaviours and solutions. They therefore are not sufficient to understand creativity in a comprehensive manner.

1.3.3 Problems in Creativity Studies

Studies investigating the development of creative thinking (e.g., Dumas et al., 2016; Shirazi et al., 2020; Ulger, 2018) have been largely focusing on creative outputs instead of the creative processes undertaken by the participants. These studies predominantly examined creative outputs based on the number of ideas produced i.e., fluency, and the originality of the outputs. They do not examine the process, or the use of strategies involved in producing these creative outputs. Therefore, this study intended to examine the strategies involved in creativity and how these strategies facilitate the creative processes.

1.4 Aims and Research Questions

This study aimed to develop a guide for creativity for educators and students, particularly higher education lecturers and students, to understand creativity and apply creative strategies to solve problems. To do this, this study developed a taxonomic framework for creativity that can be used as a guide to apply creative strategies to solve problems. In the development of the taxonomic framework, this study engaged lecturers and students from a higher education institution to identify, describe and examine the features of creativity on the taxonomic framework through a series of phases and methodologies. This study intended to:

1. develop a prototype taxonomic framework for creativity through a synthesis of literature on theories, frameworks and research on creativity.
2. explore and understand the meaning of creativity from the higher education lecturers and students' perspectives.
3. examine the creativity features and usability of the taxonomic framework based on the perceptions of creativity and the relevance of the framework among a group of higher education lecturers, students, and participant-nominated creative higher education lecturers and students.
4. examine the use of the creativity strategies in the prototype taxonomic framework for creativity through a problem-solving task.

In order to achieve these objectives, this study sought to answer the following research questions:

1. What are the features that make up the prototype taxonomic framework for creativity?
2. What are the perceptions of the reference population on creativity and the relevance of the taxonomic framework?
3. What are the perceptions of the participant-nominated creative higher education lecturers and students on creativity and the relevance of the taxonomic framework for educational purposes?
4. How do higher education students engaged in creativity tasks display performance differences without and with the use of the taxonomic framework?

1.5 Research Design

This study used a mixed-method, multiphase design to investigate the above research questions. The research comprised four phases. The first phase identified the features for creativity to arrange them into a taxonomic framework through thematic analysis. The second phase involved a survey to investigate students and lecturers' understanding of creativity and their perceptions of the taxonomic framework. The third phase comprised interviews with participant-selected creative students and lecturers for an in-depth exploration of their understanding of creativity and their perceptions of the taxonomic framework. The fourth phase examined how the taxonomic framework facilitates students' creativity in a problem-solving task. Upon completion of the aforementioned phases, this study finalised the taxonomic framework based on data collected from all four phases of the study. The first, second, third and fourth phases respectively addressed the first, second, third and fourth research questions. The overview of the research design and methodology is provided in Chapter Four of this thesis.

1.6 Context of the Study

This study was carried out in an international higher education institution in Malaysia. The participants involved in this study were lecturers and undergraduate students from the three disciplines of study offered in the university i.e., Arts, Social Sciences, Science and Engineering. The vision of the university is to establish itself as a university without borders that embraces opportunities presented by a changing world. This university also aims to inspire students, encourages creativity and innovation, and produce world-leading research and improve life for individuals and societies worldwide. As such, the university presents a multicultural, multinational context that comprises staff and students from diverse backgrounds. The university aspires to empower staff and students to solve problems and improve lives through collaboration in learning, scholarship and discovery.

1.7 Working Definition of Creativity

To develop the taxonomic framework, this study first built on existing understanding of creativity (Amabile, 1982; Amabile et al., 2005; Sternberg & Lubart, 1991) to propose an integrated definition of creativity as the working definition for this study. This study acknowledged that creativity encompasses multifaceted views; however as this study views creativity from a problem solving perspective, the working definition of creativity in this study was derived from the problem solving point of view:

Creativity is the ability to generate ideas that are *novel* and *useful* for a purposeful initiative (Amabile, 1982; Boden, 2004); this initiative is often related to *solving a problem* (Amabile et al., 2012; Sternberg & Lubart, 1991). The process of problem solving takes into account the *thinking* (e.g., Chiu, 2014; Guilford, 1950; Wang et al., 2016)*, social-emotional* (e.g., Csikszentmihalyi, 1990; Delgado, 2017), and *socio-environmental* (e.g., Fjaellingsdal et al., 2021; Rock, 2008) process involved in generating creative outputs in addressing a problem.

1.8 Significance of the Study

At the theoretical level, this study attempted to establish a taxonomic framework that does not only provide a set of strategies to perform creative actions, but also comprehensively explains factors that affect creativity and the outcomes of creativity. Findings of this study could also add to the understanding of existing theories of problem solving in relation to creativity i.e., Associationist, Gestalt and information-processing perspectives. This study may explain how existing knowledge could facilitate creativity in solving new problems, how existing knowledge can be reconceptualised to generate novel solutions and how creativity through applying and reconceptualising existing knowledge can be triggered through a systematic and strategic process to solve problems.

At the pedagogical level, findings of this study could provide recommendations on how creativity can be incorporated in the classroom. Firstly, this study examined the beliefs about creativity, creative individuals, and creative practices in teaching and learning among higher education students and lecturers. Understanding the beliefs held by students and lecturers is crucial as lecturers' beliefs may facilitate or inhibit students' creative behaviour (Beghetto, 2006) and students' beliefs may affect their desire to be creative. Therefore, findings from this study could provide an insight on whether the students and lecturers' views of creativity were in line with the current theoretical perspectives of creativity. Knowledge and awareness about these matters could strengthen the construction of our knowledge of creativity and in the long run, facilitate the implementation of creative pedagogy more effectively and efficiently.

Moreover, this study investigated the way in which higher education students engaged in a problem-solving task. It also examined if the taxonomic framework facilitated creative behaviours. Findings from this investigation may provide understanding and awareness on how a problem can be approached and addressed through a deliberation in seeking, selecting and using different creative strategies. As such, these findings could provide cognisance on how different types of creative strategies could be applied and the outcomes of these strategies on the solutions presented.

On a methodological level, this study developed the taxonomic framework through a mixed-methods multiphase design, which seemed to have yet to be employed in previous research that aimed at constructing a framework, model or taxonomy for creativity. This framework was first developed theoretically and then was examined empirically through a survey and interview with higher education students and lecturers, followed by a problem-solving task with students to examine the actual application of the strategies captured in the framework. The phases conducted in constructing the taxonomic framework may serve as a guide for researchers to develop other taxonomies alike to understand and assess a phenomenon.

1.9 Organisation of the Thesis

Chapter One dealt with an overview of the research. It began by discussing how creativity is involved and relevant in problem solving, followed by a discussion of the way in which creativity has been applied in teaching and learning. After a brief account of the problem statement, this chapter laid out the aim and research questions this study attempted to address. It then presented the significance that this study could contribute to the area of creativity in terms of theories, pedagogy and research methodology.

Chapter Two explores the literature review related to creativity. It discusses the theories, frameworks, and research in relation to creativity and problem solving, and explains how these would influence the way in which this study conceptualised creativity. Chapter Three explores the literature review regarding creativity in education. It discusses the theories related to creativity in education and examines the current research on creativity in education.

Chapter Four provides an outline of methodological concerns associated with research design, data collection instruments, data analysis, trustworthiness and ethical considerations of the research. Chapter Five details the development of the prototype taxonomic framework i.e., the features for creativity that were identified and how these features were organised into the taxonomic framework for creativity. Chapter Six compiles the major findings from the survey; Chapter Seven compiles the major findings from the interviews; Chapter Eight organises the major findings from the problem-solving tasks.

Chapter Nine is the final chapter of this thesis. It summarises the thesis contents and discusses the implications drawn from this study for teaching and learning as well as research. It also covers the discussion on the contributions and limitations of this study, as well as recommendations for future research.

CHAPTER TWO

LITERATURE REVIEW
Understanding Creativity

2.1 Introduction

The focus of this study was to develop a taxonomic framework for creativity that could be used as a foundation for teaching, learning, and assessment of creativity in the higher education context. This chapter is focused on developing a comprehensive understanding of creativity through apprehending: (i) the evolution of the concept of creativity, (ii) creativity and problem solving, and (iii) approaches to researching creativity.

2.2 Understanding creativity

Creativity has been conceptualised in various ways in history, and its conceptualisation evolves over time. When capturing the trends of creativity chronologically through history, most scholars (Craft, 2001; Carter, 2004; Pope, 2005; Runco & Albert, 2010) presented the transformations of the notions of creativity along a Eurocentric perspective using classifications of the European periods in the context of European civilisation. Eoyang (2019) raised problems regarding classifying the trends of creativity from only a western historical perspective:

> "Once one defined periods with these Eurocentric period titles, the admission of a Chinese author or a Chinese work was far from obvious. The fault lies in precisely choosing nonuniversal historical designations. Not every culture in the world had a Neoclassic period followed by a Romantic period."
>
> (Eoyang, 2019, p. 63)

As not every culture experiences similar historical movements within the same historical chronological periods, merely discussing the concepts of creativity using the Eurocentric classifications may neglect significant evolutions of the concepts of creativity in the East. As such, this review aims to provide a broad engagement with the notion of creativity from two perspectives, Western and Eastern perspectives. I use Glăveanu's (2010) three paradigms to guide my review of the shifts of the notions of creativity. These paradigms are the He-paradigm, I-paradigm and We-paradigm. The He-paradigm reflects an understanding of creativity that is largely focused on the external sources responsible for creativity; the I-paradigm gives recognition to human's ability for creativity; the We-paradigm incorporates what is now known as social psychology into the understanding of creativity. In Glăveanu's (2010) model, these paradigms largely capture the Western evolution of creativity. I expand the use of the three paradigms to the Eastern views of creativity, to understand how they are similar and different from each other.

2.2.1 The He-paradigm

This paradigm started during the Western and Eastern ancient era. The key concept of this paradigm is clearly reflected in the title of the paradigm – creativity is a third person's (He) possession – God and exceptional individuals. Creativity is either viewed as God's creation or an ability endowed to only certain individuals regarded as "genius" who produces novelties significant to the history of humanity (Glăveanu, 2010). This paradigm is sustained till the early modern era.

Generally, the ancient view of creativity, as perceived in both the West and the East, has a theological focus that is fundamentally a spiritual process involving mystical concerns. This perception is a concept of inspiration that is based on the belief that a superior power is responsible for any creative act. Such a belief can be found in Greek, Judaic, Christian and Muslim traditions (Craft, 2001; Runco & Albert, 2010). In the West, creativity during the ancient era was associated with supernatural power (Runco & Albert, 2010) and the belief that individuals and groups could be possessed by a powerful external force, of which they then become the vehicle and mouthpiece these spiritual forces (Runco & Albert, 2010). For example, the ancient Greek philosopher, Plato, insisted that a poet is unable to create without his inspiring muse (Pugliese, 2010). The Roman philosopher, Cicero, asserted that every spiritual work is accompanied by the protection of the muse (Pugliese, 2010). According to Albert and Runco (1999), the Greek, and later, the Roman cultures, developed the notions of "external creative 'daemon' (Greek) or 'genius' (Latin), linked to the sacred" (p. 18). In the modern era, these notions only approve exceptional individuals such as Einstein and Vincent Van Gogh, who made exceptional breakthrough discoveries in their inventions (Gardner, 1994).

Similarly, the Eastern perception of creativity has an association with the supernatural moral authority and the potential creator i.e., *Tian*, or Heaven (Niu & Sternberg, 2006). This mystical association has been documented in the Book of Changes (*Yi Jing*), an ancient Chinese divination text (O'Brien, 2007), which asserts that *yin-yang* is an ultimate origin of everything, and the change and interaction of *yin-yang* create the world (Niu & Sternberg, 2006). The concept is similar – creation is an ultimate origin and creativity comes from sacred, external power. While the West and East's conceptualisation of creativity appreciates spiritual values, the East does not seem to entertain the notion of creativity as entirely external (McCarthy & Pittaway, 2014). Instead, it appears to emphasise "personal fulfillment" and "the expression of an inner essence or ultimate reality" (Lubart, 1999, p. 340). Sarnoff and Cole (1983, as cited in Lubart, 1999) extend this view by claiming that this Eastern notion of creativity is a resemblance of the Western contemporary "humanistic psychology's conception of creativity as part of self-actualisation" (p. 340). This means that the Eastern point of view of creativity is about the process of personal development; it is a drive for an individual to fulfill their potentials. Maduro (1976, cited in Lubart, 1999) further stressed that the Eastern conception favours the creative person who endeavours to find their inner reality and become one with it through meditation and self-realisation. It indicates that even in the ancient time, motivation has been recognised as a drive for creativity in the East, but motivation is only recognised later in the modern West (Maduro, 1976; cited in Lubart, 1999).

In the West, the notion of creativity is derived from the Biblical story of creation in Genesis 1.1-3 (Boorstin, 1992; Pope, 2005; Runco & Albert, 2010). Particularly in the Judeo-Christian scheme, creativity is the sole province of God, in which God creates from "The Void or Nothing" (*ex nihilo*), and humans are perceived as not having the ability to create (Niu & Sternberg, 2006; Pope, 2005). Early Renaissance's major philosophers such as Davies (1592) insisted that "To create, to God alone pertains." Hobbs (1561) also declared that "To say the World was not Created….is to deny there is a God". From a superficial level, creativity may seem purely a divine act. However at a deeper level, it actually embodies the concept of originality i.e. entire newness, which serves as one of the contemporary markers of creativity.

The West's dominant perception of creativity as absolute creation somewhat contradicts the Eastern thinking about creativity. For the Hindus, Confucius, Taoists and Buddhists, creation was at most a kind of discovery or mimicry (Runco & Albert, 2010; Rudowicz, 2004; Weiner, 2000). The early Buddhists, in particular, believed in natural cycles, embraced the idea of *ex nihilo i.e., out of nothing* "had no place in a universe of the *yin* and *yang*" (Boorstin, 1992, p. 17). Essentially, the two contrasting viewpoints toward creativity held by the West and the East could be due to two different belief systems. In the West, God is viewed as the creator through the Christian teachings; this leads to the belief that creating from nothing is possible in the West. In the East however, creativity is perceived as discovering the nature or following "the Way", or the Tao. It is the natural way and truth of the universe (Rudowicz, 2004; Weiner, 2000), because the most important goal of human activity is to attain harmony with the nature or the universe (Weiner, 2000). This belief is crucial because humans can deviate from the natural order; and when they do, they bring destruction upon themselves and those around them, like the creation of weapons for wars (Niu & Sternberg, 2006). Hence within the Taoist and Buddhist teachings, creativity is to figure out how to be consistent with "the Way", instead of creating something, as they believe that there is nothing new to create (Rudowicz, 2004; Weiner, 2000). They believe in creating goodness instead of novelty, as they perceive people "who desire creating something new live in ego illusion" (Weiner, 2000, p. 160). Although the Eastern notion of creativity seems to be largely discussed within the Buddhist and Taoist perspectives, these two religions may not be the dominant religions in the East during the ancient time. Therefore, what have been discussed so far about the Eastern view of creativity may not be appropriate to be generalised as the sole ancient Eastern perception towards creativity. However, whether or not creativity is about originality or continuous discovery, the takeaway from this discussion is creativity exists in different magnitudes. Within the He-paradigm, some of the understanding of creativity influences the way in which creativity is still perceived today. Creativity is still perceived as an ability possessed by only a few exceptional people (Konstantinidou et al., 2013; Tomasevic & Trivic, 2014) who generate an idea or solution that has a major breakthrough in invention (e.g., Kaufman & Beghetto, 2009).

2.2.2 The I-paradigm

In the early modern era, the recognition of human creativity flourished in both the East and the West when human achieved success in the arts, science and technology fields (Niu, 2006; Niu & Sternberg, 2006; Weiner, 2000). The understanding of creativity expanded from one that is confined to spiritual and special individuals' ability to an ability accessible by everyone i.e., the democratic view of creativity (Bilton, 2007; Weiner, 2000). Creativity as human capacity is known as the I-paradigm. Here, creativity can be possessed by the "normal" person and is no longer a competence of the few chosen by God and biological, intellectual features (Glăveanu, 2010). In the West, the democratic view of creativity flourished when psychologists started researching on creativity in the 1950s (Glăveanu, 2010). Guilford (1950) in his APA presidential address called the topic of creativity to attention and stressed that creativity can be possessed and demonstrated by everyone. He put forward an agenda that "whether or not the individual who has the requisite abilities will actually produce results of a creative nature will depend upon his motivational and temperamental traits" (p. 444), and "creative acts can therefore be expected, no matter how feeble or how infrequent, of almost all individuals" (p. 446). Subsequently, research started to examine individual attributes and how these attributes are connected to creativity, which will be discussed in the following paragraphs.

The focus on personal attributes to creativity attempted to develop an association between creativity and the person's psychological traits (Glăveanu, 2010). This has led to the debate of whether a single outstanding intelligence determines creativity (Eysenck, 1993; Sternberg, 1990) or it is essentially a combination of different intelligences (Gardner, 1994). These different studies attempted to develop an association between creativity and the person's psychological traits (Glăveanu, 2010). Additionally, past studies on creative personality showed that personal traits such as tolerance for ambiguity (Stein, 1953), strong motivation and intuitive nature (Barron, 1999) enable creativity.

The I-paradigm's focus on individual attributes also links creativity with problem-solving (e.g., Guilford, 1968; Osborn, 1953; Wallas, 1926). Early proposals on creative process postulated that creativity involves some levels of unconsciousness, which is called incubation i.e., the period when the problem is set aside before attempting to solve it again. Incubation has been found to improve creative performance (e.g., Cai et al., 2009) as it invokes an "aha" moment (Wallas, 1926). Besides, Guilford's (1950) divergent thinking task, which was developed based on the notion that creativity is the ability to generate multiple solutions to a problem, has been used in many studies to predict creativity (e.g., Dumas et al., 2016). These studies established a close connection between creativity and problem solving, and imply that real problems need to be solved with creative thinking (Genco et al., 2012; Hu et al., 2017; Mumford et al., 1991).

In the East, on the outset, the I-paradigm was influenced by the Western theories and research on creativity (Niu, 2006; Niu & Kaufman, 2013). Empirical studies on creativity in the East started later than the West, with the earliest recorded in the 1960s (Niu, 2006). As these early studies were mostly conducted in the Chinese context (e.g., Mainland China, Taiwan, Hong Kong, and Singapore), it is inappropriate to generalise this discussion to other Eastern contexts. Nevertheless, these early studies were largely similar to studies in the West. Possibly due to the influence of the Western creativity research, research in the East, particularly Mainland China, tended to compare creative performances between Eastern and Western participants via divergent thinking tests (e.g., Shi et al., 1995; Zha, 1986). Results revealed that different cultures perform differently. Eastern Asian participants seemed to perform better in figural creativity, i.e., creativity demonstrated non-verbally usually through object drawing tasks (e.g., drawing completion task), whereas the Western participants appeared to perform better in practical knowledge demonstrated through alternate uses tasks

(Zha, 1986; Rudowicz et al., 1996). These differences were attributed to personal factors such as social values, education, degree of modernisation and other factors related to individual differences (Niu & Sternberg, 2006). The differences in cultures may have influenced the different understandings about creativity and how creativity has been expressed by different individuals.

The I-paradigm of creativity is associated with the use of psychometric approaches to study divergent thinking (Guilford, 1968) and problem-solving abilities (Sternberg, 2003; Barron & Harrington, 1981). Montuori and Purser (1997) argued that the use of psychometric approaches encourages "methodological reductionism" (p. 8), as the methodologies only took into account the individual personal factors while ignoring other external factors, such as resources at work, team support and safety that could influence one's creativity. In other words, these methodologies suggest that creativity could happen in social vacuum and is a quality of a single individual (Glăveanu, 2010).

2.2.3 The We-paradigm

This paradigm is about togetherness and interaction in the process of creativity (Glăveanu, 2010). Creativity is viewed as a result of interdependence between individuals, social situations and social practices. Creativity is no longer seen solely as individual achievement, but an achievement facilitated by the interaction between individuals and their surroundings.

The We-paradigm is a contemporary paradigm emphasising on the social psychology of creativity (Glăveanu, 2010). It is believed that studying creativity merely from the individual's thinking process and personality traits ignores external influences such as the environment and the people in the environment. As creativity research started to examine social factors in the creative process, new terms emerged to reflect the importance of the social factors in creativity. These terms include "social creativity" and "group creativity", which refer to creativity as an outcome of human interaction and collaboration (Paulus et al., 1999; Paulus & Nijstad, 2003). Stein (1975) argued that the expansion of creativity research to the process between self and others, and self and the environment allows a holistic and systematic investigation of creativity. This has given rise to the emergence of contemporary theories such as the System theory (Csikszentmihalyi, 1988) and componential model of creativity (Amabile, 1996). These theories emphasise the emergent nature of creativity as a result of the interactions between the creator, the creator's disciplinary field, and the social organisation where the creator is in.

While the shift to acknowledging creativity as a product of interaction between self, others and the environment was obvious in the West, the view that creativity is a synergy between self and the surroundings in the East is a continuation of their ancient beliefs that creativity was an interaction among the individual, the *yin* and *yang,* and other natural elements. Therefore in the East, the environment was already part of the creative process long ago. In spite of this, it is important to note that in the Eastern context, research on creativity and the socio-cultural perspective emerged only after the influence of the Western paradigm shift. At the present, creative studies from the East also investigate creativity from the social-cultural perspectives (e.g., Niu & Sternberg, 2003; Zhao et al., 2020), although not as widely as in the West. Over the years, research in creativity in the East has moved beyond merely adapting the work of the West (Niu & Sternberg, 2006), but has started to associate creativity with multitude of perspectives such as theatrical, social, and indigenous psychology (Niu & Sternberg, 2006).

It is important to note that while the Eastern view of creativity in the ancient time did not necessarily require novelty, in the modern time, perhaps because of the influence of the Western culture, the Eastern notion of creativity in the We-paradigm embraces the idea of novelty too (Niu & Sternberg, 2002). The main difference between the West and the East is that the East focuses more on moral goodness i.e., creativity must generate moral goodness alongside novelty (Niu & Sternberg, 2002). The East has always approved qualities like "contribution to the society" and "be appreciated by others" (Rudowicz, 2003, 2004; Rudowicz & Hui, 1996, 1997). On the other hand, apart from novelty, the West expects creativity to be accompanied with aesthetic and humour, where creative people seem to be able to show appreciation towards aesthetic activity and tend to be playful (Lan & Kaufman, 2012)

The use of creativity in problem solving in the We-paradigm focuses on environmental factors that stimulate creativity in the collaborative problem-solving process. These factors include composition and diversity in a team such as cultural and gender diversity among team members, and familiarity of team members (Sosa & Marle, 2015). Team members with different task experiences (Fjaellingsdal et al., 2021) and with high familiarity (Sosa & Marle, 2015) are found to increase team creativity. Creativity in problem solving has also been examined through co-construction processes where creative solutions emerge through joint discussion, sharing and negotiating perspectives (e.g., Rojas-Drummond et al., 2008).

In summary, the notion of creativity began in the ancient time as a mystical concept of behaviour and ability (He-paradigm) but evolved to an everyone's capability (I-paradigm) and finally an individual's competence nurtured by the environment (We-paradigm). The role of creativity has shifted from acknowledging the creative problem solver as exceptional genius, to predicting creative potential among general individuals through divergent thinking in problem solving and personality traits, as well as facilitating creativity in problem solving through a systematic set of procedures, and finally to understanding the collaborative and environmental aspects that stimulate creativity in problem solving.

2.3 Creativity and problem solving

From the outset, my research has argued that problems are a catalyst for creativity, or in other words, problems necessitate creativity. To justify this premise, this section provides a more detailed review of the notion of a problem and the theories of problem solving in the context of creativity.

2.3.1 Definition of a problem

Before claiming that creativity and problem-solving are inter-related, it is important to first understand what a problem is. The concept of "problem" is seen to be vague because there is a lack of a clear definition to explain it (Garlick & Thompson, 1997; Mumford et al., 1991). However, a problem can also be understood as a difficulty that causes individuals to inquire and gain relevant knowledge about the difficulty encountered (Kupisiewicz, 1964, cited in Klement et al., 2017) through active research (Okon, 1966, cited in Klement et al., 2017). A problem has also been viewed as a situation that creates inner conflict in the individuals and subsequently motivates them to look for new approaches to address the conflict (Linhart, 1976, cited in Klement et al., 2017). Both definitions suggest that problem solving requires motivation to seek solutions. As such, the problem must be something that the problem solver sees relevant and necessary to be addressed. The Gestalt Psychologist, Karl Duncker (1945) elaborates a problem as:

> *"A problem arises when a living creature has a goal but does not know how this goal is to be reached. Whenever one cannot go from a given situation to the desired situation simply by action, then there has to be recourse to thinking. Such thinking has the task of devising some action, which may mediate between the existing and desired situations."* (p. 1)

Duncker's (1945) definition of problem also focuses on solution-seeking but clarifies that a problem occurs when a person has a goal but does not have a clear path to achieve it. This problem will lead an individual to look for solutions to achieve their goals. Duncker's

(1945) definition of problem is broad enough to encompass multiple disciplinary areas such as accomplishing academic tasks like writing an essay (Kellogg, 1994), solving an unfamiliar arithmetic problem (Reed, 1999), or figuring out how an electric motor functions in subject matters like life skills and physics (Mayer et al., 2003). The definition can also be applied to nonacademic tasks like discovering how to get ¾ or 2/3 of a cup of cottage cheese (Lave, 1988, cited in Mayer & Wittrock, 2006) or deciding which is the best apartment to rent (Kahneman & Tversky, 2000). My study adopts Duncker's (1945) perspective of "problem" because of its broad application to various disciplinary areas. In my study, it is important to be able to view "problems" from multiple perspectives in the higher education context, as participants in this study were a combination of students and lecturers from different disciplinary areas.

Mayer (2013) categorises problems as either well or ill-defined, and either routine or non-routine. In a well-defined problem, the given state of the problem and the goal are clear, with a set of procedures to achieve the goal. For example, a mathematical problem like "4 x 6.8 = ___" is a well-defined problem. The problem situation is clear – it is to solve the decimal multiplication of 4 x 6.8. The goal of the problem is also clear – it is a numerical number that needs to be derived. Additionally, there is an established procedure to accomplish decimal multiplication. On the other hand, in an ill-defined problem, the given state of the problem and the goal may not be specified. There may not be a set of procedures that can facilitate goal achievement. For instance, an essay assignment on how to curb the spread of Covid-19 is an ill-defined problem. In this case, the state of the problem, which is Covid-19 is not specified. For example, it does not specify whether the individual is expected to solve Covid-19 of a specific region, or for the whole world. Similarly, the goal is not specified – what is the expected outcome of this problem? In comparison to well-defined problems, ill-defined problems, with its state and goal not specified postulates more challenges in solution identification and generation.

To consider whether a problem is routine or non-routine, the key consideration is whether there are ready-made procedures to solve the problem. A routine problem is one that emphasises the use of prescribed procedures to solve a problem. A problem is non-routine when the problem solver does not have a previously learned procedures to solve the problem. In the 21st century, problems are always ill-defined where the individuals will need to find multiple solutions due to the lack of knowledge and existing solutions for the problems encountered (Mumford et al., 1991). However for teaching purposes, Mayer and Wittrock (2006) argued that educational materials and lessons selected by educators are still mostly formed by well-defined and routine problems.

2.3.2 Problem solving in the context of creativity

As introduced in Chapter One, Mayer (1992, 2013) identifies three theoretical approaches to problem solving: (i) associationism (Thorndike, 1911, cited in Mayer, 2013), (ii) Gestalt tradition (Duncker, 1945) and the (iii) information processing approach (Newell & Simon, 1972). The Associationist theory posits that the problem-solving activity is a mental process of associating concepts and ideas that already exist in the human mind. Problem solving therefore occurs through application of already known concepts or procedures i.e., *reproductive thinking*. Previous findings (Gilhooly et al., 2007; Vallee-Tourangeau et al., 1998; Walker & Kintsch, 1985) have shown that in the problem-solving process, participants largely retrieve prior knowledge acquired through direct or indirect experiences from their long-term memory when generating ideas. While these findings indicate the importance of prior learning and experience in facilitating and guiding the problem-solving process, the use of existing associations in the mind is seen to limit the option for creativity in problem solving and downplays the role of critical insight and creativity. When confronted with a problem that may not be associated with past knowledge or experiences, one may need to rely on an *aha* moment to solutions. The concept of insight or the *aha* moment is proposed by the Gestalt theory.

The Gestalt approach contrasts the Associationist by positing that not all problems can be solved by *reproductive thinking or* by making associations with past knowledge or experiences, especially new problems. Rather, these new problems that cannot be solved by past solutions require *productive thinking* or *insights* to break away from past experiences, perceptions or knowledge to develop a new representation of the problem (Mayer, 2013). The "aha" or "eureka" moment usually occurs when the correct solution is formed (Fedor et al., 2015; Webb et al., 2016). This claim is supported by evidence involving individuals who experienced failure in problem solving but restructured their mental representation i.e., using productive thinking, to finally address the issue (Fleck & Weisberg, 2004; Weisberg & Suls, 1973). Recent studies discover that productive thinking can usually be facilitated by individuals' high working memory capacity (Chuderski & Jastrzebski, 2018; Xing et al., 2019), personality traits such as openness to experience (Chamorro-Premuzic & Reichenbacher, 2008; Yeh et al., 2020), persistence (Yeh et al., 2020) as well as contextual conditions such as the existence of priming (Mikulincer et al., 2011; Yeh et al., 2020). The Gestalt theory has been opposed by the Associationists who argued that an insight is reached through a series of reproductive thinking instead of an unexpected sudden moment (Perkins, 1981; Weisberg & Alba, 1981). This view of needing a series of reproductive thinking can be addressed by the information-processing approach (Newell & Simon, 1971).

Instead of seeing problem solving as a matter of mere insight that occurs all of a sudden, the information processing approach focuses on the thought processes that shape decision-making or problem solving (Newell & Simon, 1971; Mayer, 2013). These thought processes mainly involve two main stages, the problem space and heuristics search. A problem space refers to the mental representation of the initial state of the problem, the goal to be achieved and the possible ways to achieve the goal. Search heuristics are the search for strategies to solve the problem successfully. A prominent framework, the Creative Problem-Solving framework developed by Osborn (1953) is an example of problem-solving model based on the information processing theory that views problem solving as a set of systematic procedures (e.g., Osborn, 1953, Wang, 2019). The processes in creative problem solving can be regulated through the individual's desire to attempt unusual options, discuss possibilities with others, and make informed judgment (e.g., Isaksen & Geuens, 2007). However, this framework does not account for the environmental conditions for problem solving. It is viewed mainly from an individual, cognitive perspective.

To date, there have still been arguments on whether a creative insight is an outcome of a sudden process (Scheerer, 1963) or is led by a different set of underlying thinking process (Ash et al., 2009; Kounious & Beeman, 2015; Wiley & Jarosz, 2012). Findings have reported that problems could be solved using both reproductive and productive thinking (Fleck & Weisberg, 2004; Perkins, 1981). Reproductive thinking is required for making association with existing ideas and experiences, whereas productive thinking is required for breaking away from past knowledge to seek new possibilities. The use of reproductive or productive thinking may be influenced by the type of problem one encounters – whether it is a well or ill-defined, and routine or non-routine. This means that being able to understand the task or problem is fundamental in guiding this decision.

2.4 Framing creativity: approaches to researching creativity

Research in the area of creativity can be themed into four broad areas – cognitive processes, affective responses, sociopsychological and output approaches. Cognitive and affective approaches investigate the personal attributes to creativity. These include the individual's mental processes and affective traits that stimulate and hinder creative behaviours. The social psychological approach examines the contextual factors related to being creative encompassing the physical, social and discipline-related factors. The output approaches investigate the consequence of any creative attempt. It may be viewed as a result of cognitive processes, emotion-driven, and being bound to specific contexts or independent of any contexts. It may also be regarded as a result of a combination of cognitive, affective and contextual conditions.

2.4.1 Cognitive approaches to researching creativity

Cognitive approaches investigate the thinking process involved in being creative. Amongst the many cognitive functions related to creativity are mental processes such as making connections or associations, decision making, evaluating, and problem solving (Fisher et al., 2011). The way in which creativity is examined through these approaches depends on how creativity is oriented, namely towards exceptional individuals, general individuals, or the interdependence between individuals and their environment. In this section, I will discuss the cognitive processes examined in general individuals and eminent creators. Creative cognition in relation to contextual factors will be discussed in section 2.4.3, socio-psychology approaches to creativity.

Within the cognitive approach to creativity, intelligence emerged as a common association with creativity; however there seems to be a lack of explanation on how intellectual ability affects one's creative behaviour. The debates revolve around whether creativity and intelligence are a subset of each other, coincident sets, independent but overlapping sets, or completely disjoint sets. Although the relationship between intelligence and creativity has been investigated for over 60 years, findings are inconsistent (Kaufman & Plucker, 2011). While some findings report modest correlations between creativity and intelligence (Batey & Furham, 2006; Kim, 2006), others, especially those from self-reported data on creativity (Furnham & Bachtiar, 2008; Furnham et al., 2008) and creative achievement inventories (Carson et al., 2005; Furnham & Bachtiar, 2008) found no significant relationships. Nevertheless, there is a consensus on the threshold hypothesis, which suggests that high intellectual ability is a necessary condition for high creativity (Guilford, 1967). A minimum level of general intelligence is necessary for creative work. Truly creative work cannot be done below the intelligence threshold of approximately 120 (Guilford & Christensen, 1973). Intelligence is prominent in studies investigating the cognitive processes of creative geniuses i.e., exceptional individuals whose contributions shape humanity in history such as Einstein, Stravinsky and Gandhi. These studies agreed that eminent creators possess high level of IQ. Gardner (1993) found that exceptional individuals in his studies possess a combination of intelligences instead of a single outstanding intelligence. For example, Einstein had a strong spatial intelligence to complement his logical-mathematical strengths.

Studies investigating the connection between creativity and intelligence provide insights to the importance of possessing knowledge and applying knowledge to exercise creative thinking. In this regard, domain knowledge has been recognised as one of the main drivers for creativity (Amabile, 1995; Feldhusen, 2005; Kilgour, 2006). Previous studies demonstrate that domain knowledge serves as the information source for creative ideation (Han & Marvin, 2002; Huang et al., 2017) and idea originality (Rietzschel et al., 2007). This is because domain knowledge guides the individual to make appropriate judgment in the creative problem-solving process (Feldhusen, 2005). However, an over reliance on knowledge domain or expertise may impede the generation of original ideas as high levels of expertise have been linked to habitual thinking (Aarts & Kijksterhuis, 2000). This means that the constant use of particular cognitive structures does not allow the breaking of conventional notions. Therefore, while domain knowledge is crucial for creative thinking, individuals need to be stimulated to break away from conventions to achieve a creative breakthrough.

Divergent thinking is another cognitive aspect commonly investigated in creativity research. It is a concept developed by Guilford (1950) who sees creativity as involving thinking in various perspectives in order to arrive at several alternative solutions to a problem (Guilford, 1950, 1968). This concept, called “divergent production”, consists of four elements namely fluency (the ability to produce many ideas), flexibility (the ability to think from different perspectives), originality (the ability to produce new ideas) and elaboration (the ability to give details to the ideas produced). Divergent thinking has been proposed to be useful in predicting potentials for creativity (Bachelor & Michael, 1997; Runco & Acar, 2012). Divergent thinking is tested by requiring the participant to generate multiple solutions to a problem within a given time frame, e.g., list as many uses of a paper clip usually within two to three minutes. This test is popular in studies investigating the effectiveness of creativity training programmes (e.g., Dumas et al., 2020). Torrance tests of creative thinking (1966, 1974) that was built on Guilford’s concept is widely used in schools and universities to assess students’ creative thinking (e.g., Liu, 2020; Wang et al., 2016). These tests comprised both verbal and figural creativity tasks. Verbal creativity tasks required participants to solve problems in a verbal form. These problems include providing alternate uses to a given object and listing possible consequences to a specific scenario. The figural creativity tasks required participants to solve problems in a non-verbal, imagery form. These problems include completing incomplete drawings and producing as many images as possible by using only the given shape. However, this test has received criticism over the years. Firstly, its reliability is questioned as the paper and pencil test with time limit may affect participants' performance. Secondly, it is argued that the test does not seem to measure creativity in life and does not represent real-world problems (Brolin, 1992; Mansfield & Busse, 1981). Thus, if creativity is situated in problem solving, not only do any creative problem-solving tasks need to reflect real-world problems, but the problems should also be relevant to the participants.

Divergent thinking has a strong association with both reproductive and productive thinking, as both types of thinking could facilitate generation of multiple ideas or solutions to a problem. Although the associationist only views creativity as applying reproductive thinking to solve problems and the Gestalt theory believes that creativity is resolving problems through breaking the conventional thoughts and norms, recent studies have demonstrated that creativity in problem solving can emerge through both reproductive and productive thinking (Fleck & Weisberg, 2004; Gilhooly et al., 2007). In the literature, there are existing frameworks, taxonomies or concepts that place these two types of thinking on a continuum (Boden, 2004; Nilsson, 2011; Stahl, 1981). For example, Nilsson's (2011) Taxonomy of Creative Design proposed four categories of creative process, namely Imitation (the replication of a previous work), Variation (the modification of an existing work), Combination (the mixture of two or more works), Transformation (translating an existing work to another medium or mode) and Original creation (the creation of something previously unrecognisable) in a developmental structure. Creativity begins with replicating previous work, followed by modifying existing work, combining two or more work, changing the original medium or mode of existing work, and the most advance level of creativity is creating something completely original. In this framework, Imitation and Variation reflect reproductive thinking as they involved making association with past experiences by making no or little modification to the original ideas or solutions. Combination, Transformation and finally the Original creation reflect the gradual development of productive thinking as they, in varied degrees, involved breaking the conventions of the original ideas to generate more novel ideas or solutions. While theoretically plausible, the Taxonomy of Creative Design and other similar frameworks and taxonomies of creativity have yet to be empirically examined.

Apart from placing reproductive and productive thinking along a developmental continuum, these two types of thinking processes have also been viewed as achievable using discrete creative strategies. Eberle's (1971) famous SCAMPER framework recommends a set of strategies for creativity, namely <u>S</u>ubstitute, <u>C</u>ombine, <u>A</u>dapt, <u>M</u>odify, <u>P</u>ut in other use, <u>E</u>liminate and <u>R</u>everse. Substitute, Adapt and Eliminate reflect the reproductive thinking category because these strategies focus on altering existing ideas, whereas Combine, Put in other use, and Reverse reflect productive thinking as they focus on changing the actual function of the idea. Besides, Davis (2004) proposes two distinct creative thinking strategies, i.e., metaphorical thinking and perspective thinking. The former refers to taking ideas or words form one context and applying them in a new context; the latter refers to changing one's current perspective (e.g., reconceptualise existing knowledge) to gain a unique and appropriate solution to a problem (Miller, 2014). SCAMPER, metaphorical and perspective thinking are techniques commonly used for brainstorming purposes to achieve divergent thinking. Although they do not denote to any designated level of creative thinking, they indicate that creative problem solving can be achieved both through reproductive and productive thinking.

Among the different cognitive skills for creativity, metacognition regulates cognitive processes in any creative attempt. Metacognition is the awareness, knowledge and thinking about what and how one knows, and controls one's thinking and learning (Flavell, 1979). Previous findings have reported that metacognition serves as a mediator for success in creative problem solving (e.g., Carson & Carson, 1993; Kaufman et al., 2013; McMillan et al., 2013). In the context of creativity, metacognition relevant to creative thinking is called the creative metacognition (CMC), termed by Kaufman et al. (2013). CMC is a "combination of creative self-knowledge (knowing one's own creative strengths and limitations, both within a domain and as a general trait) and contextual knowledge (knowing when, where, how, and why to be creative)" (p. 160). Flavell (1979) proposes that creativity can be achieved by applying three types of metacognitive knowledge i.e., person knowledge (own strengths and weaknesses), task knowledge (knowledge about and skills needed to accomplish the task) and strategic knowledge (when and how to use which strategies to accomplish the task). This knowledge guides one to understand a problem or a task, understand their own strengths and weaknesses that would influence the problem-solving process, and know when and how to use creative strategies to address the problem successfully. It also guides the selection, evaluation and reselection of the right cognitive strategies when solving problems creatively. Past studies have revealed that metacognitive knowledge positively correlates with creativity in specific subjects, such as mathematical creativity (Erbas & Bas, 2015) and visual-spatial creativity involving drawing and providing titles to drawings (Lizarraga & Baquedano, 2013). Similarly, Zeng et al. (2011) showed that in the domain of IT, metacognitive knowledge about problem analysis, remote association, abstraction and IT-specific knowledge respectively facilitates problem analysis, idea generation, idea evaluation and the implementation of creativity. Apart from metacognitive knowledge, metacognitive regulation, which focuses on what individuals do about learning such as planning, examining, monitoring, testing and evaluating cognitive activities (Flavell, 1979), also contributes to one's creative attempts. Successful problem solvers of an insight problem are found to have better metacognitive regulation in monitoring, changing and adjusting strategies according to the conditions of the problem (Xing & Chen, 2009; Zhang & Xiao, 1996). The presence of high metacognition in planning, performing and reflecting has been shown to enhance creativity in generating multiple ideas (Carson & Carson, 1993; Chiu, 2014; Vernon & Hocking, 2014) and producing original ideas (Chiu, 2014; Friedman et al., 2003; Madjar & Shalley, 2008; Vernon & Hocking, 2014).

Although the studies presented above found positive correlations between metacognition and creativity, others found no such correlations. It was argued that the inconsistency in the positive correlations were partly attributed to the use of self-report, which has a high tendency to exhibit participant bias (e.g., Lizarraga & Baquedano, 2013; Preiss et al., 2016). Additionally, McMillan et al. (2013) suggested that high metacognition reduces one's inclination for daydreaming or mind-wandering, which tend to facilitate creativity through incubation and imagination. Jia et al. (2019) argued that the association between metacognition and creativity, and the roles of CMC in any creative endeavour have not been adequately explored and explained. Past studies exploring creative metacognition usually focus on one aspect of metacognitive knowledge (e.g., either strategic knowledge or person knowledge) or metacognitive regulation (e.g., either planning, monitoring or reflecting). These studies (e.g., Hong et al., 2016) then generalise the relationship between metacognition and creativity based on the type of metacognitive skill selected for their study.

Based on the review of cognitive approaches to creativity, there are several cognitive processes that are related to creativity. These are intelligence, divergent thinking, reproductive thinking, productive thinking, and creative metacognition. Intelligence may be an enabler for creativity, but it does not sufficiently explain creativity as an outcome of the complex interactions between individuals and their environments. Divergent thinking is the process of generating multiple solutions to a problem, which can be facilitated through the use of both reproductive (applying and adapting known solutions) and productive thinking (exploiting knowledge to generate novel solutions). Creative metacognition applies the self-knowledge, task knowledge and task knowledge to guide the use of reproductive and productive thinking in solving a problem.

2.4.2 Affective Approaches to Researching Creativity

> *In any given moment we have two options: To step forward into growth, or to step back into safety.*

Abraham Maslow

Affect is the emotion or desire that can influence one's thoughts, behaviours and actions. The affective dimension for creativity has long been acknowledged when researchers started to examine the affective traits of creative people through the use of psychodynamic approaches. The affective dimensions related to creativity can be classified into the emotional dispositions or emotions that influence the creativity of the eminent creator (e.g., Csikszentmihalyi, 1999; Gardner, 1993; Maslow, 1970) and general individuals (e.g., Hahn & Lee, 2017), as well as emotional responses as a result of interactions with environmental factors (e.g., Gajda et al., 2017). In this section, the affective dimensions of creativity will be discussed from two perspectives – the affective traits and affective states. Affective traits refer to the individual's emotional dispositions that reflect an individual's affective characteristics; the affective states refer to the feelings an individual undergoes when engaging in any creative tasks. The discussion on the emotional responses as a result of interactions with the environment will be discussed in section 2.4.3.

Affective traits related to creativity reflect a person's affective characteristics. There is a long list of traits that have been proposed and demonstrated to facilitate creativity and predict creative potential. These traits include perseverance (Cox, 1926; Gough, 1979; Scherer & Gustafsson, 2015), extraversion (e.g., Kaufman et al., 2015; Singh & Kaushik, 2015), confidence (Cox, 1926; Hahn & Lee, 2017; Kozbelt, 2007), risk taking (Dewett, 2017; Dacey & Lennon, 1998; Gajda et al., 2017; Gough, 1979; Lee, 2005); openness to experience (Batey et al., 2010; McRae, 1987; Kaufman, 2012; Zhou, 2001), intrinsic motivation (Amabile & Pratt, 2016; Cerasoli et al., 2014; Cox, 1926; Dewett, 2007; Feist, 1993; Liu et al., 2016) and non-conformity (Wojtowicz & Wojtowicz, 2017). Among these affective traits, perseverance, high confidence, and intrinsic motivation are characteristics demonstrated by eminent creators (Cox, 1926; Csikszentmihalyi, 1993; Feist, 1993; Kozbelt, 2007). When an individual has high perseverance, they persist to achieve a predetermined goal amidst obstacles (Scherer & Gustafsson, 2015). Extraversion is associated with individuals who are happy (e.g., Singh & Kaushik, 2015) and expressive in sharing and presenting their ideas (Kaufman et al., 2015). Additionally, risk taking invokes creativity as it prompts one to experiment problem solving from various aspects (Dewett, 2007). Willingness to take risk can be facilitated by intrinsic motivation (Dewett, 2007). To be creative, openness helps individuals to be willing to acquire new knowledge, to try and generate new ideas, and to accept new experiences (Batey et al., 2010). In Wojtowicz and Wojtowicz's (2017) study, participants with a high level of conformity tended to rely heavily on reproductive thinking, and the use of idea or solution replication as strategies. This finding consolidates the importance of open-mindedness in creativity.

While the affective traits listed above act as individual, discrete traits that facilitate creativity, Cohen (1989) proposes a continuum of seven affective traits that influence one's creativity. In Cohen's (1989) framework, it aims to conceptualise creativity as a range of adaptive behaviours along a continuum of seven levels of stages, to explain the mundane creativity found in everyday lives and extraordinary creative achievements. In this framework, the most basic level starts from curiosity, followed by inventiveness, self-directedness, self-set investigations of problems real to individuals, pursuit with purpose, problem finding, and the highest level is total commitment to create. Cohen arranged these affective traits in correspondence to the shift from reproductive to productive thinking. For example, curiosity is associated with making modifications to existing ideas, pursuit with purpose is associated with integrating multiple ideas, and a total commitment to create is associated with breaking new conventions to create something revolutionary. The problem with this framework is that whether an individual is applying reproductive thinking or productive thinking, it is an action as a result of a combination of curiosity, the urge to pursuit with purpose and commitment. Therefore, these affective traits may not be appropriate to be organised on a continuum.

While affective traits refer to a series of personality traits relevant to creativity, affective states in creativity refer to the emotional state an individual is feeling when engaging in creative processes. "Flow" and intuition have been shown as two main emotional states that facilitate expression of creative behaviours. "Flow" is "the state in which people are so involved in an activity that nothing else seems to matter; the experience itself is so enjoyable that people will do it even at great cost, for the sheer sake of doing it" (Csikszentmihalyi, 1990, p. 4). Past studies reveal that "flow" enhances creativity (Botticchio & Vialle, 2009; Schutte & Malouff, 2020; Zubair & Kamal, 2015), and it is particularly evident in work habits of those who make significant creative contributions (Csikszentmihalyi, 1990). Intrinsic motivation plays an important part in stimulating a continuous state of "flow" (Delgado, 2017; Massarella & Winterstein, 2009; Moneta, 2012). This is because when an individual is intrinsically motivated to achieve a goal, they tend to experience pleasure and satisfaction when learning, exploring ideas and accomplishing the goal (Mills & Fullagar, 2008).

Besides "flow", intuition, a tacit knowledge that guides the process of discovering new ideas and assessing whether the idea is appropriate for a problem (Dollinger et al., 2004) is also an important affective state in facilitating creativity. Intuition can be regarded as related to metacognition. According to Puente-Diaz et al. (2021), intuition in creativity is "feelings coming from the act of thinking, and thinking about thinking while one is trying to generate ideas to solve creative problem with an understanding that multiple solutions are possible and that we might not get a complete sense of being correct from any of the generated solutions" (p. 2). These intuitive feelings are guided by expertise and are automatically activated from long-term memory (Gore & Sadler-Smith, 2011). It stimulates the process of idea selection or evaluation by guiding individuals to feel if a particular idea would work (Magnusson et al., 2014; Puente-Diaz et al., 2021). Intuition develops solutions by helping individuals judge if any particular ideas can be combined in a certain way (Dörfler & Eden, 2014; Stierand & Dorfler, 2015). While Csikszentmihalyi (1993) found that eminent creators constantly experience "flow", Policastro (1995) reported that eminent creators possess and rely on their intuitive feelings of what and how the outcome of their creation would be.

Overall, there are certain affective factors that seem to be consistent across individuals who are creative. However, studies that examine the affective dimensions of creativity present with several limitations. First, using mostly psychometric instruments, the findings of most research only state the affect qualities that are conducive to creativity but do not explain how the presence and absence of these affective qualities drive or hinder creative behaviours in individuals or social groups. Secondly, studies investigating affective traits (e.g., openness, motivation) and emotional states (e.g., "flow" and intuition) rely heavily on self-report data through quantitative studies (e.g., Batey et al., 2010; Gough, 1979). Consequently, these studies predetermine the affective traits and emotional states to be investigated (e.g., openness, perseverance, flow), which limits the scope of affective dimensions related to creativity to be explored. This limitation suggests the need for a qualitative investigation to understand how affects influence creativity.

2.4.3 Socio-psychology approaches to Creative Frameworks

The cognitive and affective factors that regulate creative processes in a specific individual, are related to the He and I-paradigms. Studies that identified characteristics of creative genius reflect the He-paradigm while those that investigated qualities of creativity in general individuals reflects the I-paradigm. Those studies do not include contextual factors that influence creativity. The socio-psychology approach to creativity reflects the "We" paradigm, as it takes into account the contextual conditions that play a role in creativity. In the following paragraphs, I will discuss how physical, social and disciplinary contexts can develop or hamper creativity. Physical contexts refer to the physical environment of the context one is in. Conditions related to the physical environment include the availability of resources such as facilities, training and finance. Social contexts refer to conditions related to the social environment such as the organisation climate and team climate. Discipline-related contexts refer to the subjects or disciplinary fields one is engaged in. In the literature, different frameworks have been developed to explain creativity as an interaction between individuals' cognitive and affective factors as well as the contexts they are in. These frameworks include the Componential theory of creativity (Amabile, 1982, 2012), Investment theory (Sternberg, 2006), and the more contemporary Glăveanu's (2013) Five A's Framework. These frameworks aim to provide comprehensive explanations on the psychological and social-environmental components necessary for an individual to engage in any creative endeavours. The development of these frameworks suggests the importance of looking at creativity from multiple perspectives so that we are aware of both the internal (individual) and external factors that could come into play in facilitating creativity. Studies focusing on the social-environmental components related to creativity can be further classified into those that examine the sociocognitive perspective, and those that explore the sociocultural perspective of creative behaviours.

The sociocognitive perspective investigates how contextual conditions of the environment, or characteristics of the physical, social and disciplinary contexts affect creativity. Through the lens of the sociocognitive perspective, empirical findings have revealed that the organisation or any workplace contributes to expressions of creativity (e.g., Amabile et al., 1996). Physical conditions such as having sufficient time, material and financial means enable creativity (Amabile et al., 1996; Damanpour, 1991). Social conditions including organisations with leadership that encourages employees to innovate and create change encourage the development of individual creativity at work (Jaiswal & Dhar, 2015; Sun et al., 2014). Additionally, within a social environment, a team atmosphere that is safe, task oriented (Agreli et al., 2017) and stimulates information sharing (Li et al., 2017) eases the process of being creative. In a team, having team members with diverse task experiences (Fjaellingsdal et al., 2021) and varied cultures (Tadmor et al., 2012) have been demonstrated to trigger creativity. Brown and Paulus (2002) explain that group brainstorming with members of diverse backgrounds allows the team to "search" within the associative memory of more people. The generation of ideas with others prompt different searches within the semantic networks of different team members, and thus increase creativity. In general, studies have shown that any context that supports the development and engagement in creativity must embrace trust, safety, information sharing, and support for learning (Jehn & Bezrukova, 2004; Van der Vegt & Bunderson, 2005).

In terms of the disciplinary context, there are some beliefs about creativity being synonymous with the arts (e.g., Kampylis et al, 2009; Newton & Beverton, 2012). The study of creative genius from various disciplines such as Einstein, Vincent Van Gough and Gandhi has demonstrated that creativity does not only reside in the arts but also in science and social sciences (e.g., Gardner, 1993). This shows that subject matters or disciplines may play a part in provoking creative behaviours depending on the individuals' specific strengths. In fact, it has already been demonstrated in past studies that individuals who exhibit creativity in one domain may be less adept at performing creativity in another domain (e.g., Conti et al., 1996; Ivcevic, 2007; Baer, 1996), although some studies demonstrate otherwise (e.g., Qian et al., 2019). Regardless of the findings, the idea to be highlighted here is that subject matters may be a factor for one to exhibit creative behaviour; these subject matters do not limit to the arts.

The sociocultural perspective examines how creativity emerges as a result of collaboration among individuals. Empirical findings stemming from the sociocultural view of creativity report that creativity is a co-constructed process (Kenny, 2014; Rojas-Drummond et al., 2008). The key enablers of creativity through a co-constructed process include having a challenge that team members can collaboratively resolve, turn taking, negotiating perspectives (e.g., Goodwin, 1995; Kenny, 2014; Rojas-Drummond et al., 2008; Roschelle, 1992) and active listening (Rock, 2008). Kenny (2014) argued that having a challenge throughout a task sustains membership and interest. Being able to take turns and negotiate perspectives obligate group members to listen to each other, to learn from each other and to achieve mutual scaffolds through each other's contribution (Goodwin, 1995; Rojas-Drummond et al., 2008; Roschelle, 1992). Rock (2008) found that active listening during teamwork prevent individuals from being protective and defensive and help them expand their creative thinking through negotiating and integrating ideas from each other (Rojas-Drummond et al., 2008). The co-constructive process of creatively solving open-ended tasks with multiple solutions, requires an open mind towards diverse ideas contributed by the team members (Rojas-Drummond et al., 2006).

In summary, the environmental factors such as trust, team atmosphere, resources adequacy, and behaviours that are respectful and open to diverse opinions can lead to the development and enhancement of creativity in a social organisation or setting. Studies examining creativity from the sociocognitive view largely rely on correlational analysis based on self-report surveys. Therefore findings in these studies do not provide insights to how individuals experience creativity in their environment. Conversely, research studying creativity from the sociocultural view is largely qualitative through analysis of discourse in a collaborative setting. The analysis of discourse provides detailed understanding of effective dialogue for creativity.

2.4.4 Output Approaches to Creativity

While it is crucial to examine the individual and contextual factors that influence creativity, it is equally important to understand the outcomes that are accepted as being creative. It has been widely agreed that the outcome of creativity should include novelty and usefulness (e.g., Amabile, 1988; Boden, 2004; Cropley, 1999; Kilgour, 2007; Mumford, 2003). Novelty refers to the degree of newness of an output; usefulness refers to the appropriateness or functions of an output. Kilgour (2007) proposes that only an idea of high level of originality and high level of usefulness can be deemed creative. However, when relating creativity to problem-solving, novelty is multifaceted where it can be a totally new insight (productive thinking), or something adapted or identically reproduced from past knowledge and experiences (reproductive thinking). Therefore the creative solutions can be entirely or partially novel and appropriate to address the target problem.

Previous studies examining creative outputs can be categorised into two categories – eminent creations of reputable creative genius, and non-eminent creations produced by general individuals. Studies examining eminent creations produced by creative genius mainly objectively quantify the impact of these genius' creations (e.g., Catell, 1903, cited in Cassandro & Simonton, 2003; Simonton, 1991). Objective quantification is conducted by measuring the amount of attention each creator received through a reference work such as biographical dictionary and encyclopedia. This measurement consequently produces ranking of different influential people in history. Although this method has produced reliable coefficients in various studies across cultures, it could neglect creative outputs (Cassandro & Simonton, 2003) by ordinary people that have yet to achieve eminence.

Evaluation of the quality of creative outputs produced by general individuals is usually done in two ways. The first way is getting the domain or field experts to judge the creative outputs. Experts in the field usually judge creative outputs by independently rating the outputs using their expert knowledge and experience of the field (Cropley et al., 2011). This judgement technique, known as the Consensual Assessment Technique (CAT), has high inter-rater reliability with a panel of fewer than 13 judges (Baer et al., 2004). However, the key issue around CAT is that the domain-appropriate experts judge creativity based on their own judgment without the same expectations, where the judgers decide their own criteria independently instead of sharing the same criteria for evaluation. Therefore although this technique has high inter-rater reliability, this makes it challenging to clarify the qualities that a creative output is expected to exhibit. The second way of appraising creative outputs produced by general individuals is through a within-sample comparison where the creative outputs within the population involved in the study are compared (e.g., Dumas et al., 2016). Similarly, this evaluation is done based on rarity instead of basing it on a set of criteria. This means that only outputs with rare elements are considered creative. Neither the CAT nor the within-sample comparison provides a universal, explicit criteria to guide the assessment of creative outputs.

Creative outputs, whether by eminent creative geniuses or the ordinary person, have been conceptualised using the notions of p-creativity and h-creativity (Boden (2004). P-creativity, which is known as “personal creativity” appreciates outputs that are new or useful to the creators themselves but may not necessarily be new or useful to the wider society or field of work. On the other hand, H-creativity, known as “historical creativity,” appreciates outputs that are revolutionary. The p-creativity and h-creativity dichotomy has also been proposed, albeit using different terminologies, by other theorists such as Kuhn’s (1970) normal science and revolutionary science and Maslow’s (1967) primary and secondary creativity. P-creativity is also known as the little-c, or everyday creativity, while h-creativity is also known as the Big C creativity. The evaluation of creative outputs based on the p-creativity/little-c creativity and h-creativity/Big C creativity can be narrow as other elements of creativity that do not fall under any of these two categories will be neglected (Kaufman & Beghetto, 2009). To address this limitation, Kaufman and Beghetto (2009) broaden this dichotomy to the 4-C model. The 4-C model comprises four levels of creativity, namely mini-c, little -c, pro-c, and Big C creativity. Mini-c is to recognise the “genesis of creative expression” (Begetto, 2009, p. 2) that may not be readily recognizable, but is meaningful to the creators themselves. Little-c is to acknowledge creativity that is recognisable among a peer group. Pro-c is to identify highly accomplished creativity that has not yet achieved the eminent level. Big C is to award the eminent level of creativity such as Einstein’s creative outputs. The 4-C model aims to recognise the different levels of creativity especially in learning. While these different levels of creativity might be useful in the context of teaching and learning, they have yet to be empirically validated.

In general, although creativity has always been assessed through its output, it seems that novelty and usefulness have been evaluated subjectively without criteria that are generally agreed upon. Nevertheless, it may be appropriate to posit that whether a creative output is assessed based on its novelty or usefulness, both novelty and usefulness of a creative output may be gauged against the continuum of personal and historical creativity. In sum, without a systematic understanding of creative outputs, it is likely to be challenging for educators to describe and assess students’ creative outputs.

2.5 Conclusion

Creativity is a multifaceted concept that has undergone a drastic evolution – from being regarded as God's possession and an exceptional ability bestowed to only on a few individuals, to being accepted as everyone's ability that can be nurtured by the environment. Creativity is triggered by the need to solve a problem (Tan et al., 2009), particularly real-world problems that do not have an existing solution (Mumford et al., 1991; Tan et al., 2009). Creative problem solving could exist in a continuum – some problem solving relies on existing solutions, but some require certain levels of novelty to enhance the original solutions (Sternberg, 1999). In any case, the ability to come up with new and useful ideas applies to a wide range of problem situations. Additionally, not all problems need to be solved through breaking conventional perceptions. Novel solutions are needed when existing solutions are unable to address the issue. At the individual level, creativity has been associated with one's cognitive processes such as intelligence, divergent thinking and metacognition, as well as the affective dimensions such as openness to experiences, motivation, intuition and the ability to attain the state of "flow". At the contextual level, creativity may be enhanced or hindered due to conditions posed by the environment. At the output level, creative solutions are generally evaluated based on their novelty and usefulness. Both novelty and usefulness can be examined through taking into consideration the value of the solutions – whether the value is situated in the creator themselves, or in the society or the world.

CHAPTER THREE

LITERATURE REVIEW

Creativity and Education

3.1 Introduction

This chapter extends the understanding of creativity and creativity research to the context of education. The focus of this chapter is to discuss and understand (a) theories related to creativity in education, (b) how creativity is perceived by educators and students and the (c) methodological considerations that should be taken in this study.

3.2 Creativity in Education

In the context of education, the discussion of creative teaching revolves around teaching creatively i.e., using innovative teaching approaches to enhance learning, and teaching for creativity i.e., teaching to develop student creativity (Jeffrey & Craft, 2004; NACCCE, 1999). Beghetto (2017) expands these two views of creative teaching by adding the dimension of “teaching about creativity” i.e., teaching what creativity is. As creativity is a confluence of both the individual and contextual factors, educators need to be aware that nature and nurture are complementary in teaching and supporting creative capability.

3.2.1 Teaching about creativity

Teaching about creativity refers to teaching students what creativity is and what it entails. It requires the *Pedagogical Creative-Domain Knowledge*, PCdK (Beghetto, 2017), a combined use of creative domain knowledge (knowledge about key concepts and findings of creativity) and pedagogical knowledge (knowledge of teaching methods and their use in relation to learner and contextual variables). Educators who teach about creativity are expected to teach and demystify the concepts of creativity (Beghetto, 2017; Olson & Zanna, 1993; Plucker & Dow, 2010). To teach the concepts of creativity, educators need to be acquainted with the key concepts, theories of creativity and research findings about effective pedagogy for teaching creativity. To demystify the concepts of creativity, they are responsible for clarifying and demonstrating that creativity does not reside only in the arts domain; creativity involves applying previous knowledge and breaking conventions to generate partially and entirely new solutions; creativity does not only emerge from the “aha” moment, but can also emerge through strategic thinking; creativity does not only refer to solutions that create a breakthrough in humanity, but also solutions that are new and useful to the creators themselves. They are expected to explain to students the different perspectives of creativity i.e., the cognitive and affective processes involved in creative attempts, the contextual conditions that affect creative behaviours and what makes an output to be considered creative. The key emphasis of teaching about creativity is placed only on teaching the content of creativity. It is about teaching the content of creativity effectively (Beghetto, 2017; Olson & Zanna, 1993; Plucker & Dow, 2010). Whether or not the content is taught in a creative manner is not the focus of this type of creative teaching.

Teaching about creativity can be approached in two ways. The first is through making creativity as a standalone module (Plucker & Dow, 2010). The second is by integrating creativity into a particular subject matter. Both approaches to teaching about creativity have rarely been examined. When creativity is taught as a standalone subject or module, educators teach students concepts, theories and findings about creativity. They also apply teaching approaches that help students learn and understand the topic of creativity and help students determine which concepts or theories are relevant to them (Plucker & Dow, 2010). When creativity is taught through a particular subject, educators need to be equipped with the knowledge about creativity in relation to the subject matter being taught. For example, if the subject matter is engineering, not only do the educators support learner on the understanding on engineering, but also teach how creativity may be manifested in the context of engineering.

Teaching about creativity, whether it is approached as a standalone module or infused into another subject, can be assessed through the changes in students' knowledge and attitudes about creativity. These assessments could be students' performance on assignments, examinations, and projects or a questionnaire about their beliefs of and attitudes towards creativity (Beghetto, 2017; Plucker & Dow, 2010). Teaching about creativity has received very little attention in creativity research. Of the very few studies done on teaching about creativity, Plucker and Dow (2010) designed a standalone creativity course to teach about creativity and investigated its effectiveness through examining students' attitude change, their ability to identify their strengths, their improvement on creativity, and their awareness of personal and external factors related to creativity. Through the use of a questionnaire, observations, interviews and document analysis of textbook and syllabus, their findings revealed that students' misconceptions of creativity such as creativity is innate that cannot be trained and learned, creativity is related to age and creativity is a fuzzy, soft construct, reduced after the course. Students also believed that their creativity has been enhanced after learning the topic of creativity. However, students' improvement on creativity was only measured based on their perceptions instead of requiring them to demonstrate creativity through producing an actual output.

Teaching about creativity is the concept received the least attention. Although creative teaching has been advocated in the curriculum (e.g., Henriksen et al., 2017; Ulger, 2018), these advocates usually refer to teaching for creativity and teaching with creativity without emphasising the need for teaching what creativity is (teaching about creativity). Indeed, creativity can be developed through innovative pedagogies and through educators' demonstration of creative behaviour without explicitly teaching what creativity is; however, if students are not taught to understand creativity and their own creativity, the process of developing students' creativity may be a hit and miss situation.

In summary, teaching about creativity is explicitly teaching students the individual and environmental factors that stimulate and impede creativity. Educators who teach about creativity will have to equip themselves with knowledge about creativity and pedagogical knowledge to develop students' creative capacity. Most importantly, to teach about creativity, educators must first believe that creativity can be taught and learned.

3.2.2 Teaching for creativity

Teaching for creativity is to nurture students' creative behaviours. Similar to teaching about creativity, teaching for creativity can be achieved via standalone training programmes that aim to develop creativity or promote attitudes for creativity. It can also be integrated into any subject areas such as mathematics, science, technology and arts (Beghetto, 2017). When teaching for creativity, educators focus on improving students' creative thinking (Beghetto, 2017; Jeffrey & Craft, 2004; NACCCE, 1999).

Beghetto (2017) asserts that teaching for creativity requires *Pedagogical Creativity Enhancement Knowledge* (PCeK). It is the ability "to enhance students' creative attitudes, beliefs, thoughts, and actions in the context of other academic subject areas or in standalone creativity enhancement" sessions (Beghetto, 2017, p. 3). PCeK is an integration of pedagogical knowledge with creativity techniques and strategies. When creativity is nurtured in the context of a subject matter, students are provided with an opportunity to express creativity in relation to the subject matter being taught. Beghetto (2017) provides an example for teaching for creativity in the context of teaching elements of narrative. In this case, the teacher might provide a list of different elements for students on the top of the matrix, including setting, main characters, and conflict. The teacher then would invite students to offer examples under each column to represent a particular element of narrative (e.g., setting = remote island, haunted house; main characters = a group of zombies, a group of children). Finally, the teacher would provide students with an opportunity to express their creativity in the context of the narrative by asking them to select examples from each category and write a unique story based on those elements. Here, the students are encouraged to be creative and are given to opportunity to express creativity. Similar practices like this example may take place in everyday classrooms; however the concepts of creativity are not necessarily to be taught to the students.

The example above shows that teaching for creativity requires educators to give autonomy and agency to students through giving them choice to experiment with materials (Cremin et al., 2015). Students should also be allowed to choose the topic they want to study and the perspectives they would like to take (Cremin et al., 2006; Horng et al., 2005). Additionally, nurturing creativity requires educators to provide space for students to explore ideas and express creativity. To encourage students to generate and explore ideas, educators are found to use open questions that allow for multiple responses (Horng et al., 2005), reduce teacher speaking time (Cheung, 2013, 2016) and encourage students to take risks in producing ideas (Gadja et al., 2017). While all these are important to develop creativity, scaffolding has been demonstrated to be essential for systematically foregrounding relevant knowledge and skills in a staged manner, when necessary (Gadja et al., 2017; Gardiner, 2017; Gardiner & Anderson, 2018). Without support, the increased level of task difficulty will cause anxiety in students. Consequently, students will be less engaged in learning (Gardiner, 2017; Gardiner & Anderson, 2018). Furthermore, problem-solving approaches are found effective in invoking creativity if it involves real-world problems (Lasky & Voon, 2011). As learning tasks, problems determine students' cognitive processes and knowledge structure (Doyle & Carter, 1984); thus problems should be ill-defined that allows for multiple solutions (Neber & Neuhaus, 2012). This is because ill-defined problems support knowledge transfer, which led students to gain more elaborated and complete knowledge to solve problems (Hmelo-Silver & Pfeffer, 2004). The use of ill-defined problems has also been demonstrated to promote divergent thinking (Getzels & Csikszentmihalyi, 1976; Lee & Cho, 2007; Maker et al., 2006).

There are several ways to assess teaching for creativity. If creativity is nurtured in the context of a subject matter, students' creativity can be assessed through developing rubrics that assess both academic and creativity within the specific subject areas (Beghetto, 2013; Beghetto, 2015). If creativity is nurtured through standalone creativity enhancement programmes, the assessment could focus on appraising whether the participants show improvement in their creative performance in terms of their cognitive skills and attitude as well as beliefs about creativity. These assessments could include evaluation of self-beliefs or self-efficacy (e.g., Beghetto & Karwowski, 2017), divergent thinking tests (e.g., Guilford, 1968) and the assessment of actual creative products or solutions judged by a panel of experts i.e., CAT (e.g., Amabile, 1996), or a set of pre-determined criteria including novelty and usefulness (Cropley et al., 2011).

Teaching for creativity through standalone creativity enhancement programmes has received more attention in the literature than infusing teaching for creativity into a subject matter. The common frameworks or approaches used in these standalone creativity programmes include SCAMPER (e.g., Kamis et al., 2020), TRIZ (e.g., Dumas et al., 2016), creative problem solving, CPS (e.g., Isaksen & Treffinger, 2004; Ulger, 2018), Design Thinking (e.g., Atlan & Tan, 2020; Henriksen et al., 2017), and Goldfish Bowl method (e.g., Shirazi et al., 2020). SCAMPER and TRIZ (Theory of Inventive Problem Solving based on the objective Laws of Engineering System Evolution) are focused on developing ideation strategies or divergent thinking. CPS and Design Thinking train students to define problems, generate solutions and evaluate solutions. The Goldfish Bowl method is a discussion or role-playing method in which a group of students sit together and are separated into an inner and outer circle. In the inner circle (the fishbowl), students have a discussion or act out a scenario set by the educator; in the outer circle, students listen to the discussion or role play and take notes. After the discussion or role-play, the inner circle feedback their observations and feelings as of how it went. The outer group will then provide their feedback to the inner group. The two groups can be replaced. Finally, the whole group will discuss their performance and learning points facilitated by the educator. However, these creativity enhancement progammes have been criticised for promoting "general creativity" or "instant creativity" because the creative techniques are usually taught in a decontextualised manner without connecting them to the participants' disciplinary areas (Baer & Garrett, 2010). In spite of these arguments, previous research, through an experimental design, have found that these programmes were effective in enhancing creativity in the area of fluency i.e., the number of solutions produced (Shirazi, 2020; Ulger, 2018) and the originality of students' solutions (e.g., Atlan & Tan, 2020; Dumas et al., 2016; Shriazi, 2020; Ulger, 2018).

Due to the limitations of standalone creativity programmes, several features have been recommended as important to improve success of these programmes. These features include the training should be lengthy, challenging to the participants, engage students in cognitive processes relevant to creativity, inform students how principles and techniques of creativity can be applied in different subject matters in realistic contexts (Beghetto, 2017). Based on past studies that reported successful creativity training, the length of these trainings ranges from eight to 14 weeks (e.g., Henrikson et al., 2017; Ulger, 2018). Trainings that reported successful outcomes also engaged participants in cognitive activities related to creativity such as divergent thinking, problem definition, solution analysis and solution evaluation (Dumas et al., 2016; Isaksen Treffinger, 2004). In addition, participants are taught to apply the creative approaches in their professional domains (e.g., Dumas et al., 2016; Henriksen et al., 2017; Kamis et al., 2020).

In past studies, so far, creativity has usually been measured based only on divergent thinking performance i.e., fluency (the number of solutions generated), flexibility (the number of categories in the solutions generated), elaboration (the details given to each solution) and originality, through quantitative and statistical data analysis (e.g., Dumas et al., 2016; Shirazi et al., 2020; Ulger, 2018). These studies did not describe or measure the quality of students' creative outputs. Additionally, these studies generally do not attempt to investigate students' use of creative strategies taught in the training programme. For example, Kamis et al. (2020) employed SCAMPER to enhance creativity among fashion design students. However their study only used interviews to examine which strategies within SCAMPER that students found useful in creating original ideas, but not how these students actually used the SCAMPER strategies when producing their creative output.

In sum, while teaching about creativity teaches and raises awareness about creativity, teaching for creativity is to nurture creativity. Teaching for creativity requires educators to create a conducive environment (e.g., offer students a choice; providing tasks that allow for creativity, scaffolding creativity, teaching creative strategies to students) to stimulate and equip students with the cognitive and affective capacities for creativity.

3.2.3 Teaching with creativity

Teaching with creativity or teaching creatively is to apply principles and techniques of creativity to teaching. This form of teaching neither makes creativity as a subject or standalone module, nor does it intend to incorporate creativity as a learning outcome of any academic subjects. Instead, creativity is demonstrated in the teaching itself (Beghetto, 2017). Teaching with creativity can occur in the context of teaching any subject matters.

Teaching with creativity necessitates an integration of *creativity-domain knowledge* and *creative pedagogical knowledge,* or in short, CPDK (Beghetto, 2017). CPDK is necessary for teaching any subject (e.g., science, economics) creatively to a specific group of students (Beghetto, 2017) in a specific context determined by culture, social norms and learner characteristics. This means that knowing how to teach science to the 12th grade students creatively may not mean that the educator is able to creatively teach science to a group of undergraduate students. There are two important aspects in teaching with creativity. First, educators have to employ innovative teaching approaches to achieve learning outcomes (Jeffrey & Craft, 2004; NACCCE, 1999). Second, educators need to exhibit behaviours related to creativity such as willingness to take risks, learn from mistakes, open to ideas and tolerant of ambiguity (Beghetto, 2017). The fundamental concept of teaching with creativity in practice is that the there is no deliberate focus on developing student creativity.

Like teaching for creativity, teaching with creativity involves allowing generation and exploration of ideas (Gajda et al., 2017), scaffolding (Gajda et al., 2017; Gardiner, 2017; Gardiner & Anderson, 2018), encouraging autonomy and agency (Cremin et al., 2006; Horng, 2005), and problem solving (Lasky & Voon, 2011). However, unlike teaching for creativity where these practices involve a learning outcome that aims at developing student creativity, the same practices in the context of teaching with creativity do not deliberately aim to nurture student creativity. Instead, they aim for teaching the subject matter effectively.

Thus far in the literature, knowledge on assessment for teaching with creativity remains scarce. Traditional methods like surveys and checklists are not dynamic enough to capture the act of teaching creatively (Beghetto, 2017). For example, the creative ethos carried by the teachers in the classroom is difficult to be captured using a survey or a checklist. Gajda et al.'s (2017) study used observations to analyse the micro-level patterns of interactions amongst teachers and students in classroom discussions. They found that teachers' caring behaviour, encouraging creativity and risk acceptance were positively related to students' engagement, ideation, and self-expression. These teachers explored students' ideas and then used those ideas to build discussion with the students. Conversely, teachers who asked known questions that have a fixed answer, instantly moving to the next question, and dismissing unexpected responses were found to hamper students' creative behaviour. In general, assessing teaching with creativity appears to be more complicated than assessing teaching about and for creativity, because the creative behaviours educators exhibit and how these behaviours influence students' behaviours require a more micro-level analysis.

In conclusion, teaching about creativity is explicitly teaching all aspects of creativity including individual (cognitive and affective) and environmental factors that stimulate and discourage creativity, as well as the criteria for a creative output. Teaching for creativity is to teach creative techniques to enhance students' cognitive and affective processes for creativity through providing a creativity-enabled learning environment. It aims at providing opportunities for students to express and demonstrate creativity. Teaching with creativity requires educators to express and demonstrate their creativity in their teaching activities without deliberately allowing students to express creativity. Educators who teach with creativity demonstrate creative personalities (e.g., encouraging risk taking, allowing exploration) and creative thinking (use of innovative approaches) to achieve learning outcomes. They create a conducive environment to enhance learning without focusing on developing student creativity. In general, it is not necessary to apply all three forms of creative teaching simultaneously in any context, and being able to exercise one form of creative teaching may not mean the educators automatically know how to implement another two forms of creative teaching (Beghetto, 2017). What is more important is that educators understand the existence and differences between these different forms of creative teaching and are able to apply them for different pedagogical purposes. Only a deliberate application of creative teaching, regardless of which form, assures effective teaching and learning of creativity.

3.3 Beliefs and understanding of creativity

The three forms of creative teaching call for adequate understanding and beliefs about creativity among educators. To teach about creativity, educators need to believe that creativity is an important subject to be taught. They need to guide students to understand the concepts of creativity, to help them believe in their creative potential and capacity. To teach for creativity, educators need to strengthen students' creative beliefs and attitudes through providing them space for creative expression and teaching them a set of techniques that stimulate creativity. To teach with creativity, educators need to demonstrate creative behaviours, which may only be exhibited if they possess appropriate understanding of creativity.

Educators' thoughts and ideas about creativity and how they apply them in teaching are referred to as the implicit theories of creativity. Implicit theories or the collection of beliefs about a particular concept could determine one's attitudes and behaviours (Pintrich & Schunk, 2002). Within the concept of creativity, different individuals hold different theories of the nature and structure in describing creativity and creative people (Runco & Bahleda, 1986; Sternberg, 1985). Examples of these implicit theories include creativity is only associated with the Arts (e.g., Krampylis et al., 2009), creativity can be taught (e.g., Maksic & Spasenovic, 2018), and creativity is spontaneous (Mullet et al., 2016). These beliefs may differ in varied degrees from how creativity is defined by creativity scholars (Sternberg, 1990). In the recent systematic review of educators' beliefs about creativity (Bereczki & Karpati, 2017; Mullet et al., 2016), some beliefs projected by the educators do not reflect the explicit theories of creativity. For instance, the belief about creativity residing in the arts is not advocated by any creativity experts. Instead, the creativity experts acknowledge that some people may exhibit creativity in certain subjects or disciplines but may not be in others (Ivcevic, 2007; Baer, 1996). Additionally, educators always interpret the scholarly recognised creative traits such as non-conformity and questioning of authority as misbehaviours. They instead appreciated students' intellectual ability and social conformity (Mullet et al., 2016).

Educators' perceptions of teaching and learning have been demonstrated to influence actual practices in the classroom (Pajares, 1992; Richardson, 1996). Thus it is pertinent to review research that examines the implicit theories of creativity held by both educators and students. In the literature, more attention has been given to the educators' perceptions of creativity. These studies are mostly conducted with educators in the primary and secondary education contexts. In spite of the limited research on creativity in the higher education settings, this review provides some overview of the way in which creativity is understood by the educators and students. In general, creativity has been viewed in relation to one's thinking processes, personality traits, contextual conditions, and the value of a creative output one produces.

3.3.1 Creativity and Thinking Processes

Educators and students' conceptualisation of creativity seems to prioritise the cognitive processes for creative thinking. A large body of evidence shows that both educators (Liu & Lin, 2014; Rodgers & Jones, 2017; Vedenpaa & Lonka, 2014) and students (Petocz et al., 2009; Tsai & Cox, 2012) see creativity as a problem-solving process, i.e., to generate multiple solutions to a problem. Thus far there has not been any findings that provide an extended explanation on the participants' association of creativity with problem solving. There is a lack of information on whether the problem perceived by the participants are specific to any context or discipline, or it is a broad term encompassing various disciplines such as problem solving in the arts, science and in everyday life. There is also a lack of clarity on whether these participants relate creativity to solving unprecedented problems, or solving well-defined, routine problems. Similarly, it is unclear whether they viewed creativity as applying previous knowledge in solving a problem or breaking preconceived conventions to arrive at a novel solution. Nevertheless, these findings demonstrate that these participants' views of creativity in relation to problem solving has a close connection to divergent thinking, as they highlight the multiplicity of solutions for a problem, instead of focusing on a single, correct response (e.g., Rodgers & Jones, 2017).

Creativity is also perceived as the ability to imagine by both educators (Aljughaiman & Mowrer-Reynolds, 2005; Turner, 2013; Zbainos & Anastasopoulou, 2012) and students

(Ehtiyar & Baser, 2019; Newton & Beverton, 2012). However, these studies do not explain the mechanisms involved in imagination that invoke creativity. Another view of creativity includes making connections among ideas as perceived by the educators (Kleiman, 2008). The process of making connections between things are believed to assist in finding new connections (Kleiman, 2008). In the context of teaching and learning, making connections is associated with educators' ability to connect any subject or content to students' perspectives or life to make it relevant and meaningful to students (Cremin et al., 2015; Craft et al., 2014). It is also related to the educators' ability to connect learning content to real world contexts (Maksic & Spasenovic, 2018). Unfortunately, such real-life connection has not been a common practice among educators (Maksic & Spasenovic, 2018).

As discussed in Chapter Two, metacognition (e.g., Erbas & Bas, 2015, Vernon & Hocking, 2014), intuition (e.g., Dollinger et al., 2004) and "flow" (e.g., Schutte & Malouff, 2020) stimulate creative endeavours. However, these three aspects have not been prioritised by educators and students in past studies. These could be the limitation in previous studies as they are mainly quantitative in nature through the use of a questionnaire. The lack of opportunities for participants to freely express their beliefs may have contributed to the lack of details and comprehensiveness in previous findings. Additionally, while the association between intelligence and creativity have been debated in the literature, educators' attributing students' creativity to academic capability (Gralewski & Karwowski, 2013; Hong & Kang, 2010; Konstantinidou et al., 2013) has been seen as a lack of understanding of creativity.

A key area to be highlighted here is that although creativity has been seen as various thinking processes such as problem solving, imagining and making connections, what has not been reported is the participants' awareness of the varied degree in thinking processes that enable creativity such as reproductive thinking, i.e., drawing from previous knowledge and experiences and productive thinking, i.e., producing novel ideas or solutions (Mayer, 2013). If these participants are not aware of these thinking processes, there is a likelihood that they may not recognise and appreciate the importance of imitation in the process of developing creativity. They may also only endorse creative outputs that are highly original instead of those that have yet to achieve eminence. In the context of education where students' creativity is continually developing, being able to recognise both reproductive and productive thinking processes is necessary and important among educators. This knowledge is particularly needed for educators to exercise all three forms of creative teaching.

3.3.2 Creativity and Personality Traits

While the literature shows that educators view creativity as a series of thinking processes (Liu & Liu, 2014; Rodgers & Jones, 2017; Zbainos & Anastasopoulou, 2012), when asked to describe creative individuals, educators and students tended to associate creative individuals with individual personality traits. The traits highlighted in creative individuals include being motivated (Horng et al., 2005; Jahnke et al., 2015; Pavlovic et al., 2013), empathetic (Craft et al., 2014), passionate (Craft et al., 2014; Aljughaiman & Mowrer-Reynolds, 2005), open-minded (Tsai & Cox, 2012; Jahnke et al., 2015), risk-taking (Tsai & Cox, 2012), reflective, autonomous (Jahnke et al., 2015), curios (Aljughaiman & Mowrer-Reynolds, 2005; Pavlovic et al., 2013), persevere and confident (Horng et al., 2005).

Motivation is a common trait possessed by both creative students and educators (Horng et al., 2005; Jahnke et al., 2015; Pavlovic et al., 2013). Being intrinsically motivated makes educators and students view any creative pursuits as enjoyable (Horng et al., 2005; Pavlovic et al., 2013), satisfying and a personal challenge (Horng et al., 2005). As a result, they constantly search for ways to accomplish goals differently. Another trait being associated with creative students and educators is their passion or enthusiasm for their disciplines or learning (Craft et al., 2014; Aljughaiman & Mowrer-Reynolds, 2005). Craft et al. (2014) found that educators' passion for the subject and for teaching drives them to yearn for knowledge in their expertise and to make teaching captivating, inspiring and relevant to students. Through their passion projected through teaching, they inspire students to develop enthusiasm for the subject being taught (Craft et al., 2014). This parallels to teaching with creativity, where student creativity can be inspired through the educators' creative behaviours.

Besides, empathy and honesty are two other traits identified as associated with creative educators. These two traits are less known in the literature. Craft et al. (2014) stress that empathy guides creative educators to feel students' feelings towards learning (e.g., fatigue) and subsequently find different ways to help students engage and reengage with their lessons. Additionally, educators who are honest in admitting their own weaknesses is believed to be open to students' views about their limitations, find ways to improve themselves and be willing to build trust between students and educators (Craft et al., 2014). These two traits are considered as important characteristics for educators to build positive rapports with students, as good rapports promote a sense of security that mediates creative behaviours.

Although a series of personality traits relevant to creativity have been identified, there have been some educators who associate creativity with students' gender (Beghetto et al., 2011; Gralewski & Karwowski, 2013) and age (Urhahne, 2011). Thus far, empirical studies on creative ability are inconclusive with reference to the impact of gender references (Baer & Kaufman, 2008; Pagnani, 2011; Runco et al., 2010). Similarly, empirical investigations on whether age matters in creativity have been scarce and inconclusive (Haavold, 2020; Rietzschel & Zacher, 2015), as studies investigating age and creativity seem to demonstrate that domain knowledge plays a more important role in creativity, which explains why older individuals seem to be more creative (Chan & Zhao, 2010; Haavold, 2020). Therefore, educators' association of creativity with gender and age would not help in facilitating the teaching and learning of creativity. Additionally, some educators still believe that creativity is a born characteristic possessed only by a minority of people (Konstantinidou et al., 2013; Lasky & Yoon, 2011; Tomasevic & Trivic, 2014). This therefore calls for a need to develop more empirical findings to show that creativity is not just innate but can also be learned and taught. This evidence can be used to address educators' beliefs and mindset about creativity and education. In sum, the understanding of personality traits in creativity is particularly important for educators to develop awareness of traits that are crucial to provoke creative thinking among students, instill positive traits in students that support creativity, and to demonstrate these traits in the classroom.

3.3.3 Creativity and Contextual Conditions

Environmental factors play a crucial role in supporting the development of creativity in education. These factors can be related to the home environment and work environment. Home environment has been perceived to facilitate the development of creative behaviours (Horng et al., 2005). However, factors related to home environment have yet to be clearly specified. Work environment factors are resources in the teaching and learning context that enable creativity. These resources include ICT facilities and curriculum that advocates creative teaching (Scott, 2015; Tomasevic & Trivic, 2014). Several conditions are perceived to disparage creative attempts. First, overloaded curriculum and heavy workload do now allow sufficient time for incorporating creativity in lesson preparation (Kampylis et al., 2009; Scott, 2015). Consequently, time pressure does not allow educators to indulge in the creative thinking process. Secondly, large class sizes that suppress student engagement is perceived to constrain student creativity (Hong & Kang, 2010; Kampylis et al., 2009). Thirdly, the lack of freedom and autonomy given to educators is perceived to oppress creativity as it does not encourage educators to experiment with innovative teaching (Hong & Kang, 2010; Kampylis et al., 2009; Kleiman, 2008). Finally, although there is a general belief that creativity is a teachable skill to everyone (e.g., Henriksen & Mishra, 2015; Hong & Kang, 2010; Maksic & Spasenovic, 2018), there have been confessions among the educators that they lack knowledge about creativity (Hong & Kang, 2010) and they do not have the skills to teach and assess creativity (Hong & Kang, 2010; Kampylis et al., 2009; Konstantinidou et al., 2013). These educators acknowledge the lack of training and skill development (Cheung, 2012; Cremin et al., 2015; Kampylis et al., 2009) as a barrier to creativity.

Although it has been acknowledged that creativity transcends disciplines and domains, it is still common for educators (Krampylis et al., 2009; Zhou et al., 2013) and students (Kampylis et al., 2009; Newton & Beverton, 2012) to relate creativity mainly to the arts (Kampylis et al., 2009; Newton & Beverton, 2012; Zhou et al., 2013). The general belief was that the arts-related subjects such as music, English, arts and Drama offer more opportunities for creative thoughts and expressions (Krampylis et al., 2009) and that creativity is easier to be manifested in these subjects by nature (Newton & Beverton, 2012; Zhou et al., 2013). This constrained association of creativity to only the arts would limit opportunities to design an engaging and creatively stimulating curriculum (Mullet et al., 2016). Consequently, students may not be given equal opportunities to explore and express creativity in other subjects.

Within the students' beliefs about the contextual concerns of creativity, past studies found that while students believe that a supportive education climate and stimulating teaching activities nurture their creative behaviour, these conditions are perceived to be lacking in practice (Ehtiyar & Baser, 2019; Maksic & Spasenovic, 2018). This is not surprising as educators are found to have yet to be ready for creative teaching due to the lack of support for creative teaching (e.g., Kampylis et al., 2009; Konstantinidou et al., 2014).

When it comes to the sociocognitive perspective of creativity i.e., the contextual characteristics that affect creativity, past findings have shown that educators prioritise the availability of resources, such as autonomy (e.g., Hong & Kang, 2010; Kampylis et al., 2009), facilities (e.g., Scott, 2015) and training (e.g., Cheung, 2012). Other factors such as team characteristics (e.g., diversity in team members) and atmosphere (e.g., safe, trusting, collegial) have not been highlighted in those studies. Additionally, the sociocultural perspective of creativity has rarely been studied too. Craft et al.'s (2014) study found that creativity is believed to emerge when educators' pose questions to students. However, there is not enough information to understand how creativity develops from other elements of interactions and social engagement among individuals in the learning context. Although studies investigating the co-constructive process of creativity have identified factors that promote creativity such as negotiating perspectives (e.g., Kenny, 2014; Rojas-Drummond et al., 2008) and active listening (Rock, 2008), educators and students involved in past studies rarely demonstrate understanding of the roles these factors play in facilitating creative behaviours. Understanding contextual conditions relevant to creativity is crucial is it supports educators to teach about the environmental factors for creativity, and to set up conducive environments for learning when teaching for and with creativity.

3.3.4 Creativity and the Value of Its Outcome

Just like other disciplines, creativity has also been associated with originality or novelty by educators (Hong & Kang, 2010; Horng et al., 2005; Jahnke et al., 2015; Kleiman, 2008) and students (Ehtiyar & Baser, 2019; Petocz et al., 2009; Tsai & Cox, 2012). However, how originality could be demonstrated in teaching and learning is not always clearly explained in the literature. Thus far, there seems to be no consensus to what constitutes originality in students' learning output. Educators often rely on intuitive judgment when assessing the originality of students' work (Myhill & Wilson, 2013). In spite of these ambiguities, Kleiman's (2008) study revealed that lecturers define originality of students' outcome in various degrees, ranging from something modestly new to the creator themselves to something that is ground-breaking which leads to a paradigm shift. Kleiman's (2008) findings align with the assumptions of existing creative concepts and frameworks which propose that creative outcomes generate values with varied degrees of eminence, ranging from personal to historical creativity (e.g., Boden, 2004; Kaufman & Beghetto, 2009).

Besides originality, usefulness or appropriateness is often required for an outcome to be perceived as creative. While usefulness is valued by some educators (Daskolia et al, 2012; Kleiman, 2008; Lasky & Yoon, 2011), it is rarely associated with creativity (Hong & Kang, 2010; Stone, 2015; Zhou et al., 2013). Similar to originality, there is no clear criteria to appraise the usefulness of a creative outcome in the context of teaching and learning. However, Craft et al.'s (2014) study suggests that creative teaching should enhance students' understanding and develop students' creative thinking. In the literature, there is a scarcity of findings about students' views of usefulness or appropriateness as part of creativity.

Based on the literature discussed in Chapter Two, this study postulated that whether creativity is conceptualised based on novelty or usefulness, a creative outcome can be appraised against a continuum of personal to historical creativity. Apart from Kleiman's (2008) study, this awareness was not demonstrated by other educators and students. This may be explained by their lack of awareness about the existence of both reproductive and productive thinking in creativity. If creative outcomes are not perceived from a continual perspective, it may be difficult for educators to appreciate and recognise students' creative potential. Without appropriate understanding of what creative outcomes entail, it may impart the wrong conceptions of creativity and inappropriately disparage students' outputs that do not reflect high levels of creativity.

In conclusion, from the research perspective, the scope of creativity research in education seems to be narrower than creativity research in other domains. Studies are conducted mainly from the I-paradigm perspective that focuses on the cognitive and affective processes. While creativity research in general has now expanded to the we-paradigm, the focus on this area is not yet apparent in creativity research in education.

3.4 Methodological Considerations for Creativity Research

Although educators and students are able to conceptualise creativity into different perspectives i.e., thinking processes, personality traits, contextual conditions and outputs, past studies usually focused only on one single dimension, either the individual or the environmental factors instead of acknowledging the confluence between the two (Petocz et al., 2009). This constraint could be due to the methodologies used. Past studies commonly use questionnaires to examine beliefs about creativity (e.g., Aljughaiman & Mowrer-Reynolds, 2005; Gralewski & Karwowski, 2013). Consequently, the predetermined constructs in questionnaires would not have allowed these studies to explore other beliefs about creativity beyond the preselected constructs for investigation.

Moreover, sampling in past research is a limitation. Craft et al. (2014) pointed out that past studies examining educators' beliefs about creativity rarely examine the lived experiences of creative educators and students. Studies investigating beliefs of creativity among general educators have found that these educators encountered problems regarding assessing creativity (Kampylis et al., 2009; Konstantinidou et al., 2013) and that creativity has been perceived to be constrained by institutional environments and students' expectations (Kleiman, 2008). However, studies involving the creative lecturers found that these creative lecturers believed that creativity is to be aware of the available tools and resources and mental factors that are required to expand students' knowledge (Craft et al., 2014; Jahnke et al., 2015). These creative educators and students are found to provide a more holistic insight of what creativity entails in the context of teaching and learning compared to studies that involved general educators and students (Craft et a., 2014). To gain a deeper understanding of how creativity is operationalised in the teaching and learning context, the selection of participants needs to be taken into careful consideration.

Based on these points, it is important to provide opportunities for participants to express their beliefs about creativity. This could be done via an open-ended questionnaire or an interview. Additionally, it may be an appropriate move to include both general and creative educators and students to gain a more comprehensive insights into how creativity occurs in the context of teaching and learning. While it is important to identify and understand the way in which creativity is conceptualised among educators and students in general, it is equally crucial to explore how creativity is understood and manifested in teaching and learning, which is more likely to be holistically expressed by lived creative individuals in education.

3.5 Conclusion

In the context of teaching and learning, creativity can be inculcated in several ways. First, educators could raise awareness about the individual factors (cognitive and affective), contextual or environmental factors for creativity and how creativity can be considered as creative (teaching about creativity). Second, educators could set up a conducive environment to stimulate and nurture students' cognitive and affective capacities for creativity (teaching for creativity). Third, educators could create an environment for creativity by being the students' role model and inspiration through demonstrating creativity cognitively and affectively (teaching with creativity). Regardless of the means to inculcate creativity, recognising that creative outputs comprise a range of values, from one that is personal to the creators themselves to one that is historical is important. This is because acknowledging personal creativity is crucial for appreciating and developing students' creative potential. Positioning creativity from the problem-solving perspective, this study viewed "problems" as an important context or "environment" that could stimulate the cognitive and affective perspectives for creativity. Therefore the "problems" presented in the classrooms determine the amount of and the quality of opportunities for students to exercise creativity.

In conclusion, creativity needs to be inspired, nurtured, and explicitly taught to awaken students to new possibilities by allowing them to transcend mundane experiences and limitations. Creativity drives individuals from apathy to possibility, and most importantly, transforms the way individuals perceive their own capabilities. In view of the importance of nurturing creativity in education, a taxonomic framework for creativity that this study intended to develop should be systematically organised to allow for teaching, learning and assessing creativity in future.

CHAPTER FOUR

METHODOLOGY

4.1 Introduction

This chapter provides an overview of the methodology used in this study. Previously developed frameworks and taxonomies on creativity were based the cognitive, affective, sociopsychology and the output dimensions of creativity. However, when researching creativity, previous studies either adopted one or two of these dimensions but have rarely incorporated all four dimensions into studying creativity. Additionally, these frameworks and taxonomies are also largely theoretical in nature and have not been examined empirically. This study therefore attempted to address this limitation by developing a taxonomic framework from multiple dimensions of creativity that will be subsequently developed and refined through empirical investigations.

This study comprised four specific investigations. The specific details of the methodology used in each investigation will be provided in their respective chapters i.e., Chapters Five, Six, Seven and Eight. This chapter begins with an explanation of the philosophical stance taken in this study i.e., the research paradigm, epistemological, ontological and axiological positions of this study. It then discusses the choice of research design and the different phases involved in this study. The chapter then explains the instruments used to collect data, analyse data, the way in which trustworthiness was enhanced and the ethical considerations in this study.

4.2 Philosophical Perspective of the Study

4.2.1 Research Paradigm

Paradigm is a set of beliefs and values that guide researchers to choose the most appropriate approaches to study a particular phenomenon and interpret their data (Saunders et al., 2016). In this study I chose a pragmatic paradigm because it “focuses on ‘what works’ as the truth regarding the research questions under investigation” (Tashakkore & Teddlie, 2003, p. 173). This research explored the “truth” from the perspective of lecturers and students. I aimed to develop a creativity taxonomic framework that is not just based on recommendations by creativity scholars but supported by the lecturers and students’ understanding of creativity. In line with the pragmatist perspective, my study employed a combination of qualitative and quantitative methods to address the inquiries of this research. This study acknowledged the challenge that the concept of creativity is abstract and complex. Therefore, multiple stages of investigation and multiple sets of data were necessary. The study employed mixed methods using a survey, interview and problem-solving task with introspective, retrospective and self-reported information.

4.2.2 Epistemology

Epistemology is about the nature of knowledge and the processes undertaken to approach the sources of knowledge (Saunders et al., 2016). In this study, knowledge is viewed as constructed and interpreted based on experience (Kaushik & Walsh, 2019) and reasons (Brandon, 2011). Therefore the findings interpreted throughout the study were constantly developed through to critical evaluation, refinement and revision (Brandon, 2011). In this study, the meaning of creativity was developed based on multiple perspectives. It was first developed based on the meaning constructed from the literature, followed by the meaning constructed by higher education students and lecturers across disciplines

4.2.3 Ontology

This study took a non-singular ontological perspective, which suggests that there is no single reality because every individual has their own interpretations of the reality (Kivunja & Kuyini, 2017). The phenomenon investigated in this study i.e., creativity, can be defined from many perspectives – there is no single notion about creativity. It could be understood differently by different individuals due to different roles, expertise, experiences and cultural backgrounds. As a result, I needed to select different participants i.e., lecturers, students as well as creative lecturers and students from different disciplines to unravel how creativity is exercised in teaching and learning.

4.2.4 Axiology

Axiology is concerned with the values, norms and beliefs that researchers hold and the role they play in the research (Collis & Hussey, 2009). This study investigated the participants' conceptions of creativity, their views of the taxonomic framework and the use of the taxonomic framework in a problem-solving task. Due to the concern about perceptions and engagement with the framework, the values, beliefs and impacts of the researcher could render the research process to be biased and value-laden. The participants may respond in a way that they think the researcher may want them to respond. Additionally, they may not be able to be honest as they may be concerned about them being judged or examined. To minimise these potential biases, I constantly reminded the participants in all phases that the objectives of the study was to understand their perceptions of creativity and to gain their feedback to improve the taxonomic framework. I assured them that this study did not assess their views of creativity, and that their identity would be masked.

Additionally, for the problem-solving task, the major concern was the Hawthorne effect i.e., tendency for the participants to modify their behaviour because they are aware that they are being studied (Gale, 2004; Sommer, 1968). They may not honestly articulate their thoughts during the problem-solving process due to my presence. To address this possibility, I emphasised that the research was not about assessing their performance in the task; instead it was to help me explore the thinking process involved in problem solving and to find out from them how I could improve the taxonomic framework. Moreover, I also used different methods i.e., protocol analysis, pair discussion and stimulated recall to triangulate data from these different sources.

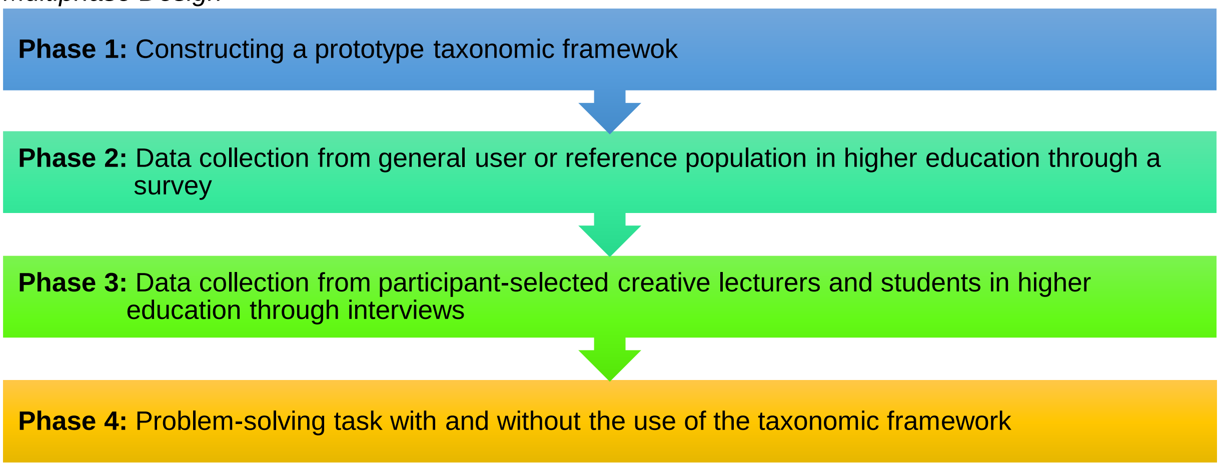
4.3 The Research Design

This study adopted a mixed-methods design for two reasons. First, the integration of qualitative and quantitative data helps to achieve a more complete understanding (Bryman, 2006; Creswell & Tashakkori, 2008) of creativity. In this study, I quantified the higher education participants' understanding of creativity and their views of the taxonomic framework to gain an overall perception of creativity in the higher education context and the relevance of the framework in this study. I also investigated these areas further through a qualitative means to gain an in-depth understanding of creativity and the relevance of the taxonomic framework. Additionally, I explored the thinking process involved in creative problem solving and the way in which the framework facilitated creativity through a qualitative means. Second, I needed both the quantitative and qualitative methods to enhance the credibility of the findings of this study (Bryman, 2006). In this study, I chose a multiphase mixed-methods design. This design combines both sequential and/or concurrent strands (Creswell & Plano Clark, 2011). In a multiphase design, a problem or topic is examined through a series of phases or separate studies. Each phase requires different research methods and participants (Creswell, 2012). This design was selected for several reasons. Firstly, the multiphase design can be used for developing a programme or evaluation (Creswell & Plano Clark, 2011). In the process of developing the taxonomic framework, this study needed to explore the concept of creativity from existing literature. Once the prototype taxonomic framework was developed, it needed to further explore the understanding of creativity from actual students and lecturers and their opinions of the framework. When the framework was strengthened based on the participants' feedback, I needed to find out if the framework worked in actual practice. All these inquiries could only be achieved through the use of a multiphase design. Thirdly, the multiphase design allows for the flexibility to use the mixed-methods design elements to address a set of research questions (Creswell & Plano Clark, 2011). In each phase, researchers are allowed to design, conduct, and interpret a qualitative, quantitative or mixed-methods study to address the research questions. Such flexibility therefore allows me to achieve my objectives of each phase using methods that best suit to explore creativity, confirm the creativity features in the taxonomic framework and assess the relevance of the taxonomic framework.

The multiphase mixed-methods design of this study was structured into four phases leading to the development of the taxonomic framework for creativity. These phases are shown in Figure 4.1. The phases of the research are (i) constructing a prototype taxonomic framework for creativity, (ii) data collection through reference population in higher education through a survey, (iii) data collection through participant-selected creative lecturers and students through interviews, and (iv) problem-solving task without and with the taxonomic framework. Within each phase of the research, different methodologies and samples were involved. These details will be presented in each findings chapter i.e., Chapter Five, Six, Seven and Eight.

Figure 4.1

Multiphase Design



Once the prototype taxonomic framework was developed, the framework was examined by students and lecturers through a survey and one-on-one interviews. The last phase aimed to verify the usefulness of the taxonomic framework in facilitating creative behaviours in actual practice. Details of each phase of this study will be provided in their respective chapters.

4.4 Research Context and Participants

This study was conducted in an international university in Malaysia. This university is an international context where its staff and students are of different nationalities (East and West), cultures, experiences and educational backgrounds. This university comprises three faculties, i.e., Faculty of Arts and Social Sciences, Faculty of Science and Faculty of Engineering.

This study intended to develop a taxonomic framework for creativity that could be applicable across different contexts of higher education. In this study, while the multi-nationality of the participants could add values to the adaptability of the taxonomic framework, it is important to acknowledge that this study took place only in one higher education institution. Hence other than the participants' sociocultural backgrounds, the climate and culture of the institution may also have influenced the way in which the participants perceived and responded to creativity. In this study, I collected data from students and lecturers across disciplines from all three faculties. This study however did not intend to examine if the participants' national backgrounds influence their perceptions of creativity.

4.5 Research Phases

This section explains the participant selection and data collection methods at each phase of the research. It also states the outcome produced from each phase. Table 4.1 below presents the details of the research phases. Each phase respectively addresses each of the research questions of this study.

Table 4.1

Research Phases

Phase	Participants	Sampling Technique	Methods (Instruments)	Outcome
One	--	--	qualitative	• Prototype taxonomic framework • Survey
Two	• 105 teachers • 334 students	purposive sampling	quantitative and qualitative *(survey)*	• Refined taxonomic framework
Three	• 12 creative teachers • 12 creative students	purposive sampling	qualitative *(individual interviews)*	• Improved taxonomic framework

Four	• 4 students from Science • 4 students from Arts and Social Sciences • 4 students from Engineering	purposive sampling	quantitative and qualitative *(problem-solving task)*	--

Throughout the process of developing the taxonomic framework, each phase of this study involved different participants and employed different sampling techniques and instruments. Findings gathered from each phase were used to strengthen the taxonomic framework before the next phase began. Upon completion of the data collection, data collected from all phases were reexamined to form a holistic understanding of the findings to finalise the taxonomic framework. The section below will briefly explain the key information about each phase i.e., the purpose and the research questions being addressed. Further details will be discussed in their respective chapters.

4.5.1 Phase One: Constructing a Prototype Taxonomic Framework

This phase aimed to construct a prototype taxonomic framework for creativity. The framework development process was constructed through a thematic analysis of the literature. Previous studies that develop a taxonomy recognise that this is an important initial phase to gain background information and understanding of the existing research and debates relevant to the topic (Colling, 1999; Massey et al., 2015; Valentijn et al., 2015). This phase addressed the first research question i.e., *"what are the features that make up the prototype taxonomic framework for creativity?"* Once the prototype framework was constructed, I developed the survey for the next phase of the study. The details of the first phase will be discussed in Chapter Five of this thesis.

4.5.2 Phase Two: Data Collection from General Users or Reference Population in Higher Education

This was the first phase where empirical data was collected. In the literature, studies aimed at developing a taxonomy gained data from general users after constructing the draft taxonomy through the review of literature (Nübold et al., 2017; Valentijn et al., 2015). In this study, this phase aimed to achieve two goals via the use of a survey. First, it intended to investigate the beliefs and understanding about creativity among higher education students and lecturers. Second, it aimed to examine the students and lecturers' views of the taxonomic framework. Their feedback was then used to assess and refine the framework. The research question to be addressed at this phase is "*what are the perceptions of the reference population on creativity and the relevance of the taxonomic framework?"* The participants were selected through a purposive sampling technique. They were 105 higher education lecturers and 334 second-year undergraduate students from various disciplines.

The primary aim at this phase was to gain as much information as I could to generate a wide range of views and ideas about the notion of creativity and the taxonomic framework from the participants. The data collected from this phase was analysed both quantitatively using a Friedman test, Wilcoxon Signed Rank post-hoc test and frequency count, and qualitatively through a thematic analysis. Based on the data gained from this phase, the prototype taxonomic framework was strengthened and open to further development in the next phase i.e., the interview phase.

4.5.3 Phase Three: Data Collection from Participant Selected Creative Lecturers and Students in Higher Education

In the literature, the reliance on experts has been another important phase that yield important insights to the development of the taxonomy. This phase has usually been conducted by asking experts to provide feedback and comments on the preliminary taxonomy (Antonakos & Colling, 2001; Snow & Reck, 2016; Valentijn et al., 2015). It can be done through interviews or group discussion such as the Delphi study (Valentijn et al., 2015), or getting experts to rate the items or constructs covered in the taxonomy (Antonakos & Colling, 2001). Experts at this phase could be people who received relevant training and demonstrate qualifications in the field of research, including a history of published articles in referred journals, presentations at national meetings, and research experience on the phenomenon of interest (Grant & Kinney, 1992; Antonakos & Colling, 2001). In this study, the criteria for experts would not be those who are well recognised in their disciplines, because being an expert in their field may not mean they are creative in teaching. This means that their knowledge in their expertise may not be equivalent to their creativity in teaching. As such, in this study, the experts would be lecturers and students who demonstrated creativity, selected by the reference population involved in the survey phase.

The use of the survey at the previous phase enabled me to explore the general lecturers and students' beliefs about creativity and their perception of the taxonomic framework. However the use of the survey did not allow me to probe further and follow up for clarification. Informed by previous studies that develop a taxonomy, I intended to gain a more in-depth perspective about creativity and the relevance of the taxonomic framework through interviews with the participant-nominated creative individuals. The interviews were to help me gain discreteness, clarity and coverage of the information I needed (Scott & Morrison, 2005) to understand creativity and the usefulness of the taxonomic framework. To do this, there were three objectives to be achieved at this phase. The first was to investigate further the notion of creativity held by a group of creative students and lecturers. The second was to explore the way in which creative students and lecturers exercised and demonstrated creativity. The third was to improve the framework for educational purposes based on the feedback from the creative students and lecturers. The research question to be addressed at this phase is "*what are the perceptions of the participant nominated creative higher education lecturers and students on creativity and the relevance of the taxonomic framework for educational purposes?"*

At this phase, I used a purposive sampling technique to select participants. At the previous phase, the students and lecturers had nominated creative students and lecturers through the survey. Based on their nominations, I collected data from the creative students and lecturers. The participants were selected based on the number of nominations they received. In total, 12 students and 12 lecturers were interviewed. According to Malterud et al., (2015), interviewing six to 10 participants from various backgrounds would be able to reach a saturation point. Thus I should be able to gain sufficient data with a total of 24 participants from different disciplines. The intention to interview the participant nominated creative students and lecturers was because these participants' "expertise" in being creative in teaching and learning would form a strong basis for me to gain an understanding of creativity from the educational perspective. The interview data was analysed through a thematic analysis. Based on the data gained from this phase, the taxonomic framework was improved (see Chapter 7 for details).

4.5.4 Phase Four: Task Based Assessment of Participant Creativity With and Without the Taxonomic Framework

This phase was the final phase of this study. The final phase of the taxonomy development could involve students' use of the taxonomy (Massey et al., 2015). This phase therefore examined the usefulness of the taxonomic framework in actual practice. To achieve this aim, I invited higher education students to take part in a problem-solving task. The research question to be answered at this phase was "*how do higher education students engaged in creativity tasks display performance differences without and with the use of the taxonomic framework?"*

Through a purposive sampling, 12 third-year undergraduate students from all three faculties (four from each faculty) took part in a problem-solving task. Out of four students from each faculty, two students did the task individually and performed a think aloud protocol; another 2 students completed the task as a pair. They completed the same task twice – first without the taxonomic framework and then with the taxonomic framework. All students were involved in a stimulated recall each time they completed the task. Data was collected from three sources i.e., think aloud protocol, pair discussion and stimulated recall. The data was analysed using a protocol analysis and frequency count.

4.6 Trustworthiness of Data

In this study, several steps were taken to increase the level of trustworthiness of the findings through credibility and confirmability. Credibility establishes whether the findings represent reasonable information drawn from participants' original data and is a correct interpretation of the participants' original view (Lincoln & Guba, 2000). I ensured credibility through the use of method triangulation, data triangulation and intercoder reliability. Through method triangulation, I investigated the concept of creativity through a synthesis of review of literature, a survey and interviews with higher education participants. I also examined the relevance of the taxonomic framework through a survey, interviews, and a problem-solving task with higher education participants. Though data triangulation, I collected data from different groups of participants to gain multiple perspectives of the concept of creativity and the relevance of the taxonomic framework. I collected data from general higher education lecturers and second year undergraduate students, participant-selected creative lecturers and students, as well as third-year undergraduate students. All these participants came from various disciplinary areas i.e., Arts and Social Sciences, Science and Engineering. Collecting information using multiple methods and different groups of participants helped assure the topic of investigation i.e., creativity had been studied holistically, and the relevance and appropriateness of the taxonomic framework was examined thoroughly from multiple perspectives. To increase objectivity in the initial phase of coding, I invited an inter-reliability coder in phases II, III, and IV to respectively code data for the survey, interviews, and problem-solving task. The coder independently coded 10% of the survey, interview and problem-solving phase data.

Another measure I took to enhance credibility of data was through piloting all the instruments used in the study. Based on Connelly's (2008) advice, the number of participants involved in the pilot studies were 10% of the estimated sample size for my actual study for phases II, III and IV. The pilot study for survey involved 30 participants (20 students and ten lecturers); the pilot study for interviews involved four participants (two students and two lecturers); the pilot study for problem-solving task involved eight students. The pilot studies aimed at assessing the data collection protocol and the suitability of the instruments used for collecting data at phases, II, III and IV. The details of the pilot study for each phase will be presented in their respective chapters i.e., Chapter Six, Seven and Eight.

Another consideration about the credibility of my data was the Hawthorne effect i.e., the possibility for the participants to alter their behaviour as a result of their awareness of being observed (Gale, 2004; Sommer, 1968). The tendency for this effect to occur was higher for the interviews and the problem-solving phases. With my presence during the interview, the participants may provide responses that I as the researcher would like to receive instead of providing their genuine accounts. Similarly, with my presence in the problem-solving phase during the think aloud protocol and stimulated-recall interviews, the students may not be openly thinking aloud their mental processes and honestly reflecting their problem-solving process. They may feel obliged to respond in ways that would please the researcher (me). To reduce the Hawthorne effect, I emphasised that the research was not about assessing their views or knowledge about creativity and their performance in the task; instead it was on exploring how lecturers and students perceive creativity and to find out from them how I could improve the taxonomic framework. I encouraged them to be as open and honest as possible in order for me to understand creativity from their perspectives and improve my taxonomic framework. Additionally, specific to the problem-solving phase, I did a method triangulation i.e., think aloud protocol, pair discussion and stimulated-recall interviews to validate their responses through the convergence of data from all different sources.

Confirmability is concerned with whether the researcher's interpretations and findings are clearly derived from the data (Lincoln & Guba, 1986). I ensured confirmability by constantly reading, rereading and analysing the data. I also recoded and relabelled codes, categories and the themes. I studied the data until the final themes provided the intended depth of insight for each area I investigated i.e., definition of creativity, relevance and appropriateness of the taxonomic framework, and the problem-solving task. Additionally, I ensured that at the final phase, I analysed data from all phases gained from different methods and participants to form a comprehensive understanding in order to finalise the taxonomic framework.

4.7 Research ethics

Prior to data collection, I submitted a research ethics approval form to the University Research Ethics Committee. I ensured that this research abided the university's research code of conduct, British Psychological Society's code of ethics and conduct, and the Economic and Social Research Council (ESRC) research ethics framework. Data collection commenced only after the ethics application was approved.

Prior to participating in my study, I gave my participants an overview of the study to provide them with an understanding of the objectives of my study, and what would be expected of them. They were informed both verbally and in written (in Participant Information Sheet) that they were not obliged to take part in my study, and were allowed to withdraw from it anytime without having to provide any reason (see APPENDIX I for the Participant Information Sheets and Consent Forms for Survey, Interview and Problem-Solving Phases. A sample of the signed consent form for each phase is appended).

All data were treated confidentially, and only I could have access to the raw data. Abiding by the current Data Protection Act, data gained from this study was kept in a secure and confidential location. Participants' names did not appear on any database, and will not appear in any information that is subsequently published. A number or a pseudonym was used as an identifier on all data associated with the participants. The master copy of the names associated with each number was kept in a secure and confidential location. The instruments used in this study only contained questions that focused on their views toward creativity and the taxonomic framework, as well as their problem-solving processes; the questions did not require participants to reveal anything personal about themselves.

4.8 Summary

This chapter has presented and explained the choice for the philosophical positions, research design, research procedures, instruments, and data analysis in this study. It also has discussed the ways in which to increase trustworthiness and explained the ethical considerations in this research. The multiphase, mixed methods research design adopted in this study involved four phases i.e., (i) developing the prototype taxonomic framework from creativity through a synthesis of literature, (ii) data collection with reference population through a survey, (iii) data collection with participant-selected creative students and lecturers through interviews, and (iv) data collection through a problem-solving task with higher education students. Altogether, 117 lecturers and 358 students from various disciplines took part in the different phases of the study. Data was analysed using both quantitative and qualitative methods. The studies conducted in each phase will be presented and discussed in the subsequent chapters.

CHAPTER FIVE

PHASE I:
Identifying and Arranging Features of Creativity into a Taxonomic Framework

5.1 Introduction

This chapter details the first phase of this study, which aimed to develop a prototype taxonomic framework for creativity for the higher education context. This chapter presents a study that attempted to develop a taxonomic framework from multiple dimensions of creativity that will be subsequently developed and refined through empirical investigations reported in the next chapters. To develop the creativity taxonomic framework, this phase identified features for creativity using a systematic synthesis of the literature through a thematic analysis. These features were then organised into a taxonomic framework for creativity that will be further developed and refined together with the lecturers and students of the higher education institution. The first phase specifically addressed my first research question i.e., *what are the features that make up the prototype taxonomic framework for creativity through a synthesis of the literature?*

A taxonomy can be defined as a systematically organised framework of labeled sets, groups, or classes linked according to designated criteria (Rasch, 1987), and can be organised in a hierarchical fashion (Rich, 1992). A hierarchy in a taxonomoy is usually organised in two ways – from specific to broad classifications, and from lower to higher level of complexity. Regardless of the way in which the hierarchy is organised, a taxonomy classifies items in a systematic order to indicate natural relationships, which in turn can help understand the connection between the items (Rich, 1992). The modern concept of a taxonomic system was developed by the Swedish botanist Carolus Linnaeus in the 18th century to standardise the naming system for animal and plant species (Dupre, 2001). This classic taxonomy uses seven tiers with increasing specificity, beginning from the top with Kingdom, and progressing downward to Phylum, Classes, Order, Family, Genus and Species. The similar structure was also used in classifying products (Howard, 1983). In the context of education, the most well-known and widely referred to taxonomy was Bloom’s Taxonomy developed by Benjamin S. Bloom. This taxonomy was structured in a hierarchy from the simplest to the most complex cognitive competences, namely Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. Regardless of the types of taxonomy, a taxonomy is essentially human constructs based on the idea of natural classification, in which members of each taxon at each level is similar to each other, and yet distinctive to members of other taxa at corresponding levels (Sokal, 1986). Therefore there is no specific theory for classification system methods (Dupre, 2001). Instead, a “fit for purpose” pluralistic method that allows for and expects some subjectivity is endorsed (Mckercher, 2016). However, for a taxonomy to be intellectually valid, it should separate elements of a group into subgroups that are mutually exclusive, unambiguous and include all possibilities (Dupre, 2001).

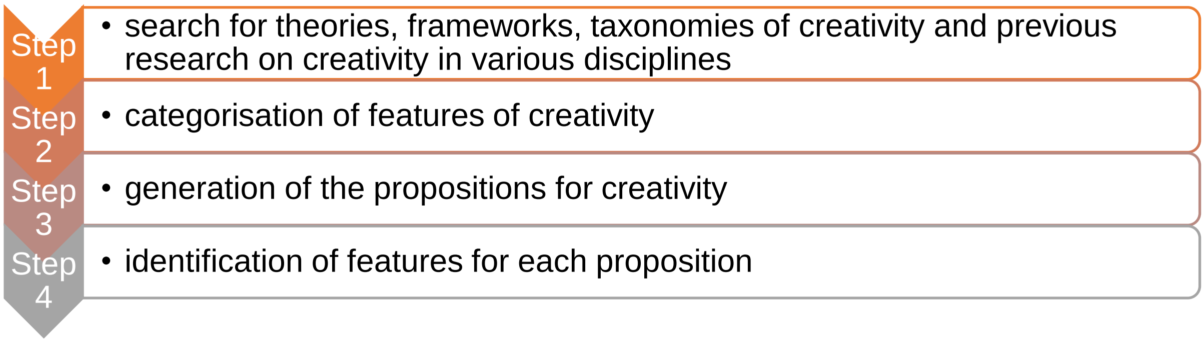
5.2 Data Collection Procedure and Analysis

The development of the taxonomic framework adopted some of the principles of scoping review (Arksey & O’Malley, 2005) to search the creative features reported in the literature as comprehensively as possible. The steps used to develop the taxonomic framework are illustrated in Figure 5.1. Step 1 involved a search for theories, frameworks, taxonomies of creativity and previous research on creativity in various disciplines. Materials selected for review included both academic and non-academic publications. Academic publications encompassed peer-reviewed, empirical and non-empirical articles selected from databases including Scopus, ERIC, ScienceDirect, PsycINFO and SpringerLink. Non-academic publications encompassed two blogs related to creativity. These blogs were reviewed as the frameworks discussed in these blogs are commonly used frameworks that have been usually reported in non-scholarly publications (e.g., FourSight, Interaction Design Foundation). The points of view in these non-scholarly publications were important as academic publications judged by experts who have established perspectives and paradigm of a field may act as a barrier to publishing new and unconventional ideas (Jesson et al., 2011). The criteria for publication selection for review are:

- Conceptual studies that discuss frameworks, taxonomies and models of creativity
- Empirical studies on creativity

Figure 5.1

Data Collection Method



A total of 65 materials, comprising 44 empirical studies, 19 non-empirical articles published in journals and edited book chapters, and two blogs were identified for review. Creativity research articles that employed brain studies e.g., neuroscience of creativity, were excluded as this area was not within the scope of this study.

Overall, there were 26 publications and two blogs that explored the cognitive perspectives of creativity, nine publications that examined the affective perspectives of creativity; seven studies that investigated the sociopsychology perspectives of creativity and nine studies that examined creativity from the output perspectives. One study investigated both the cognitive and output perspectives; three studies investigated both the cognitive and affective perspectives, four studies examined both the affective and sociopsychology perspectives; three studies examined the cognitive and sociopsychology perspectives, and one study incorporated a combination of cognitive, affective and sociopsychological views of creativity.

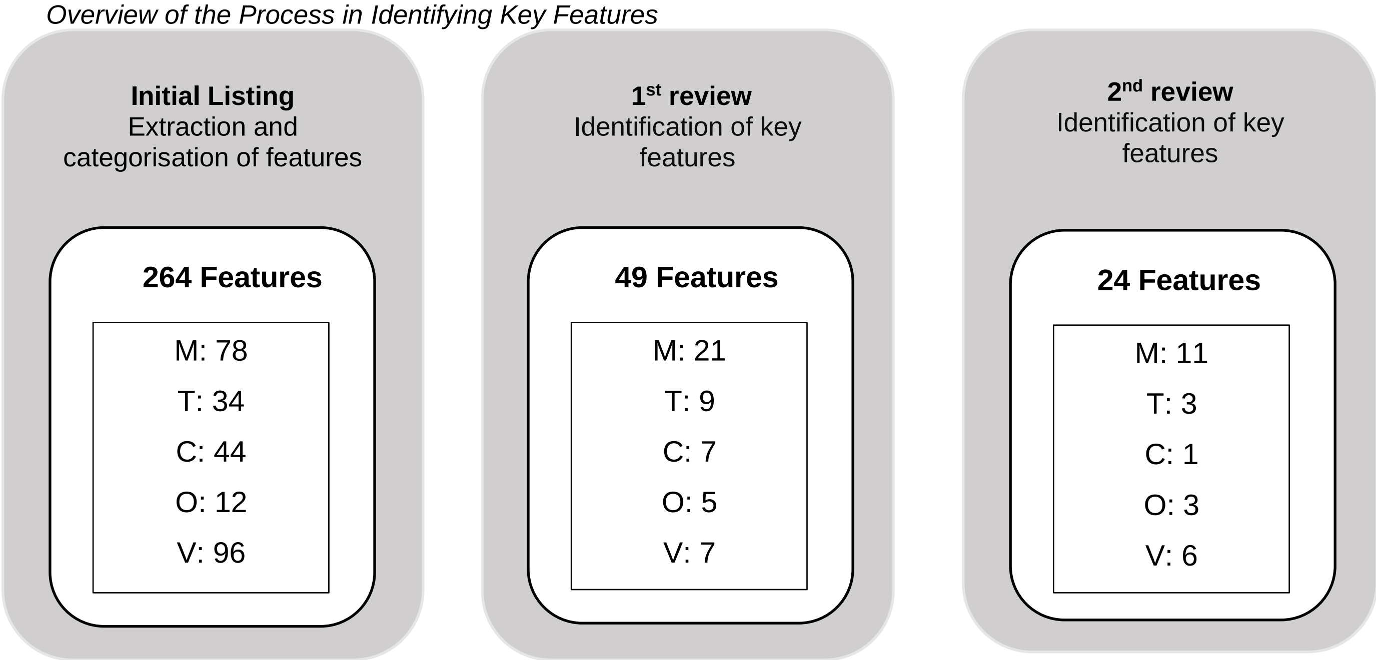
In Step 2, I used Braun and Clarke's (2006) principles of thematic analysis to derive themes from the features. First, I identified all features of creativity from the (i) definitions of creativity, (ii) components of creativity presented in existing theories, frameworks, taxonomies for creativity, and (iii) findings of the empirical study on creativity. This process generated an initial list of 264 features (see APPENDIX A for these features).

In Step 3, from the 264 features, I organised them based on the definitions presented in their respective publications. Features with the same terminology and same definitions were merged as one. Features with different terminologies but similar definitions were also merged into one terminology (e.g., relevance and appropriateness were termed as usefulness).

Features with the same terminologies but different definitions were distinguished with new terminologies (e.g., “elaboration” that refers to a team’s constructive discussion is different from “elaboration” that refers to the details given to an idea or solution. Therefore, the former was termed as “co-constructive discussion” and the latter was kept as “elaboration” as this term was a common term used to refer to the details given to an idea or solution). The first attempt ended up with 49 features. These 49 features were then reviewed to ensure that they were individually distinct and did not overlap with each other. The second attempt, which was also the final attempt, generated 24 features. The overall process in identifying the key features, from 264 to the final 24 features is presented in Figure 5.2. Within these 24 features, five themes emerged, they were (i) Mental, (ii) Trait, (iii) Context, (iv) Outcome and (v) Value. Each theme was renamed as a “proposition” as each theme postulated a distinctive perspective of creativity. The Mental proposition refers to the cognitive processes involved in being creative. This proposition consisted of 11 features. The Trait proposition, made up of three features, refers to the personality and characters that support creative behaviours. The Context proposition, comprising one feature, establishes that creativity can be both bound to specific contexts or be independent of any context. The Outcome proposition, made up of three features, refers to the consequences of a creative act; the Value proposition, which consisted of six features, denotes to the significance or impact of a creative outcome. These five propositions underpinned the definitions of creativity for this study and the taxonomic framework.

Figure 5.2

Overview of the Process in Identifying Key Features



Note. M=Mental; T=Trait C=Context; O=Outcome; V=Value

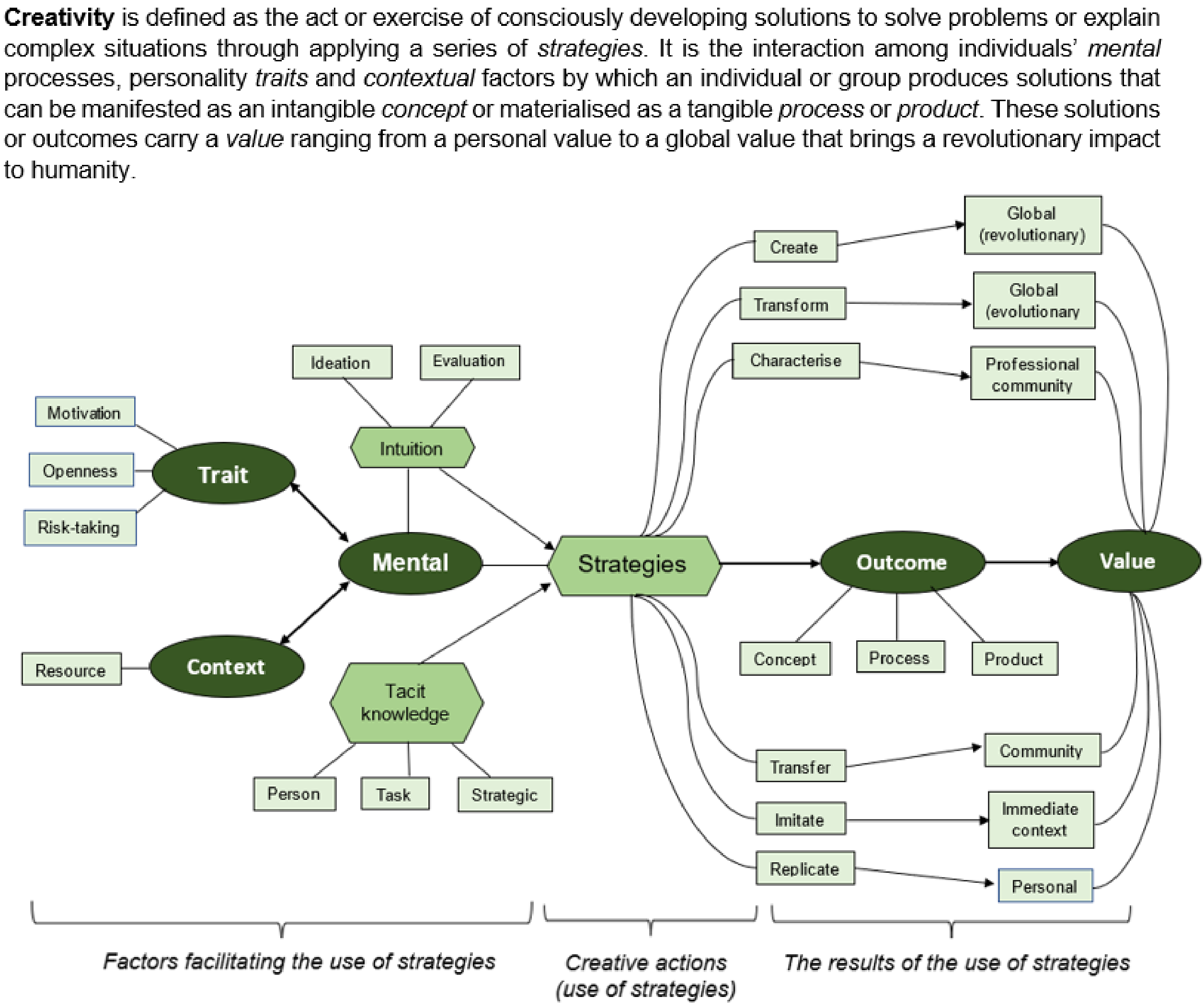
The final 24 features from the five propositions were then translated to a thematic map to depict the relationship among these features within these propositions. The thematic map is presented in Figure 5.3 in Section 5.2.1.

5.2.1 Propositions and Features of the Prototype Taxonomic Framework for Creativity

The taxonomic framework for creativity was made up of 24 features drawn from five propositions i.e., Mental, Trait, Context, Outcome and Value. I will explain the connection among these propositions with the thematic map illustrated in Figure 5.3 below. In general, creativity can be exercised through the use of strategies in solving problems; the use of strategies is facilitated by several factors and will lead to varied results. The definition of creativity in this study is incorporated in Figure 5.3 to explicate the connections among the five propositions.

Figure 5.3

Thematic Map of the Five Propositions with Respective Features that Underpin the Taxonomic Framework for Creativity



Note. The identified 24 features are labelled.

The Mental, Trait and Context propositions were intertwining propositions that would contribute to the Outcome proposition leading to different levels of significance captured in the Value proposition. This means that the confluence between the individual's mental processes, personality traits and the contextual conditions the individual is in will lead to a creative outcome that contains a value. To demonstrate the interconnection among the propositions, I will explain each feature with their relevant propositions based on three segments i.e., (i) the use of strategies, (ii) factors facilitating the use of strategies and (ii) the results of the use of strategies.

5.2.1.1 Mental Proposition – The Use of Creative Strategies to Invoke Creative Actions

The Mental proposition which focuses on the mental processes in creative thinking, comprises features that relate to the (i) creative strategies, and (ii) factors that support the use of the creative strategies. The term “strategies” in this framework refers to the intentional and strategic approaches in developing solutions to a problem. This study postulated that creative actions can be supported with applying a set of strategies. The six strategies listed in the taxonomic framework are *Replicate, Imitate, Transfer, Characterise, Transform* and *Create*. The explanation of each of the six strategies below will be exemplified by the solutions used in treating cancers or organ failure. The choice of using medical-related examples was because these examples may be ones that are familiar among and understood by people across disciplines. It is important to note that these examples do not reflect the chronological development of solutions for cancer or organ failure treatments. The examples are only used to explain the strategies.

Replicate is to reproduce an existing solution in an identical manner to address an identical or similar problem or situation. Replication is achieved through adoption of an existing solution. For example, when treating a patient with organ failure or cancer, a doctor uses known and approved surgical procedures to remove the affected area of the organ. This strategy involves an association of the problem with previous knowledge and experiences.

Imitate refers to modelling after an existing solution not in an identical manner to address a similar problem or situation. Imitation may be a modification or an adaptation of an existing solution. For example, the invention of a pacemaker and dialysis machine to respectively treat heart failure and kidney failure involves the process of imitation. This process mimics the concept of the rhythmic contraction of cardiac muscle of the heart regulated by the sinoatrial node of heart (for pacemaker) and some functions of the kidney to remove waste products from the blood (dialysis machine). In the case of the pacemaker, cardiac stimulation is done by having electrodes to generate electrical pulses to cause the heart muscle chambers to contract and therefore pump blood (Mallela et al., 2004). In the case of the dialysis machine, it was invented via studying and modelling fluids through semipermeable membrane to act as an artificial kidney (Gottschalk & Fellner, 1997). Imitation may be used when Replication is unable to solve the problem. For example, Replication (surgery to remove affected areas of the organ) is unable to solve heart and kidney failure as a diseased heart cannot be removed, and a removal of kidney may not be the best solution to treat kidney failure.

Transfer refers to developing a product or solution by borrowing from other sources of similar or different nature. *Transfer* refers to adapting the entire or part of the existing solution from a related or unrelated field. An example of *Transfer* is the process of coming up with chemotherapy as a treatment to cancer. How chemotherapy reflects *Transfer* is by using Nitrogen Mustard gas, which was a resource initially used to make weapons for wars, as an anti-cancer drug (DeVita & Chu, 2008). Here, the knowledge on military science is transferred to the medical field.

Characterise is developing a solution through the characterisation of the problem. The solution may be generated through adapting the existing solution. To explain *Characterise* more clearly, I compare the example used for *Transfer* i.e., chemotherapy with the one used for *Characterise* i.e., targeted therapy. Fundamentally, targeted therapy was developed to help stop cancer cells from growing. The question to be raised here would be why targeted therapy is developed when chemotherapy serves the same purpose, which is to kill cancer cells. The reason is because while chemotherapy kills cancer cells, it also destroys the healthy ones (Sudhakar, 2009); this consequently leads to side effects like hair loss, blood loss and even organ damage. As such, targeted therapy may be developed to solve the problems raised as a result of the use of chemotherapy. In general, the key skill involved in *Characterisation* is the in-depth breaking down of a problem to develop an improved product or solution.

Transform is synthesising features from two or more solutions to develop an advanced solution to address a new problem or situation. The solution may be developed through the manipulation and reconceptualisation of existing solutions. An example to illustrate *Transformation* is the process involved in developing organ transplant to treat organ failure or cancer. The key features for *Transformation* are “synthesis” and “applying existing knowledge in new ways”. These two points would further explain the *Transform* strategy using the example of organ transplant. Firstly, organ transplant is a synthesis of different medical features including the features of a surgery and immunotherapy through immunosuppression. Secondly, organ transplant underlies applying existing knowledge in new ways through the use of surgery and immunotherapy. Initially, surgery had always been used to remove affected area of a diseased organ; however in organ transplant it is used to remove an organ from one body and place it in another body. Likewise, immunotherapy was first used by stimulating patients’ immune response to fight cancer. Nevertheless in organ transplant, instead of increasing patients’ immune response, it weakens it to reduce patients’ reaction to the transplanted organ (Gutiemez-Dalman & Campistol, 2007). This strategy involves exploring and combining multiple solutions and putting existing solutions in a different use.

Create is to hypothesise and generate completely anew solutions or a synthesis of diverse existing knowledge in unconventional ways to create new solutions. The difference between *Transform* and *Create* lies in the difference that *Create* involves forward thinking to generate solutions that could potentially solve future problems. A completely new solution will be generated through the creation of solutions that are significantly different, relevant and more advanced than existing solutions. In this framework, I am using "cloning" to exemplify *Create*. The key feature in this strategy is "forward thinking". It is a mindset that is invested in the future. The idea of cloning reflects forward thinking as it leads to development of new medicines (McKinnel & Berardino, 1999).

The six strategies discussed above, from *Replicate* to *Create* reflect a continuum of reproductive to productive thinking. *Replicate* and *Imitate* apply existing solutions to solve problems, which reflect higher degree of reproductive thinking. *Transfer, Characterise, Transform* and *Create* gradually move towards the productive thinking end of the continuum, as these strategies, in increasing degrees, apply a shift in perspectives to come up with more novel solutions. The level of creativity and complexity in thinking increases gradually from *Replicate* to *Create*. According to Cohen (1989) and Sternberg (1999), these different levels of thinking may lead to different contribution or value of an outcome produced. The value of a creative outcome generated by each strategy will be discussed in section 5.2.1.6.

5.2.1.2 Mental Proposition – Mental Processes as Factors that Support Creative Actions

Creative actions exercised through the use of the six strategies needed to be facilitated by several factors. In the Mental proposition, factors that support the use of the six creative strategies are intuition and tacit knowledge. The use of the creative strategies would be enhanced when tacit knowledge and intuition were activated simultaneously. Within one's intuition, *Intuitive ideation* could work as an associative process linking together distinct pieces of stored information, and also restructuring and recombining them into a coherent, task-relevant solution. *Intuitive evaluation* would guide the individual to recognise and judge if a solution would be perceived as significant in a given social context. Tacit knowledge comprised *person knowledge*, *task knowledge* and *strategic knowledge*. *Person knowledge* is linked to the individual's knowledge about themselves i.e., their characteristics, ways of thinking, strengths and weaknesses. Sufficient knowledge about themselves enables them to make use of their own strengths and overcoming weaknesses in applying any strategy to solve a problem. *Task knowledge* is the individual's knowledge about the task or problem that needs to be addressed. This includes the knowledge about the type of problem involved – whether it is a well or ill-defined problem, and whether it is a routine or non-routine problem. It is also the individual's understanding of the initial state and the goal state of the problem. *Strategic knowledge* is the individual's knowledge about the range of creative strategies, why and how to apply them to solve a problem. The individual needs to understand the advantages, disadvantages and the applicability of each strategy. Tacit knowledge that captured these three features (*person, task*, and *strategic knowledge*) could regulate the creative problem-solving process by guiding the problem solver to understand the problem, understand themselves as problem solvers and identify appropriate strategies and evaluate the chosen strategies to ensure problems are solved successfully.

5.2.1.3 Trait Proposition – Trait as Factors that Support Creative Actions

The Trait proposition posited that creativity can be supported by the individual's personality traits. Features that mark the Trait proposition were *motivation, openness* and *risk-taking*. Creativity requires the compulsion to work hard in any area of interest, which involves the individual's intrinsic *motivation*. In this framework, *motivation* means that the individual has to feel the need for addressing a particular problem. Such purposeful drive toward solving a problem requires the individual's *openness to possibilities* such as new ideas and experiences. One's appreciation of diverse perspectives and a willingness to try new things can better navigate challenges and discover novel and appropriate solutions. Even when an individual is equipped with motivation and openness to possibilities, having a *risk-taking* attitude could support the individual to try new ideas and experiences without worrying about the possibility of failure.

5.2.1.4 Context Proposition – Context as Factors that Support Creative Actions

The individual factors i.e., mental processes and traits discussed above needed to be supported by contexts. The Context proposition proposed that creativity can be both bound to specific contexts or be independent of any context. The key feature of this proposition is *resources. Resources* here encapsulated a broad concept including a positive home or work environment, supportive leaders, collegiality among colleagues and availability of facilities. It highlighted the importance of utilising any resources available to the individual to exercise creativity. This framework did not intend to provide an exhaustive list of contextual conditions, but to highlight "*resources*" to underline the role a context plays in encouraging creative acts.

As discussed in the literature, creativity can be resulted from the individual's cognitive and affective abilities to be creative; however, the understanding and development of creativity would only be complete and successful if the contextual factors for creativity are taken into consideration.

5.2.1.5 Outcome Proposition – The Outcome of Creative Actions

Creative acts can be accomplished through applying creative strategies facilitated by the individual and contextual factors. Such creative acts would lead to varying results captured in the Outcome and Value propositions. The Outcome proposition refers to the consequences of a creative act. Features that describe the Outcome proposition included a *concept, process* and *product*. *Concept* is an abstract idea that is not materialised; *Process* is a set of methodologies or procedures to undertake or implement a concept; it may be viewed as an overarching idea that proposes a solution to a problem. *Product* is a concrete outcome manifested from a *concept* and/or *process*. *Concept*-based solutions are abstract ideas that underpin the *process* or *product*-based solutions; *process* and *product*-based solutions are concrete solutions that can be operationalised. Taking the concept of “teaching for creativity” as an example, the theory of “teaching about creativity” is a *concept*. It is proposed as a solution to addressing the need for developing student creativity. As a concept, “teaching for creativity” appears significant and meaningful, but the big questions remain on how this *concept* may be practically operationalised. To operationalise this *concept,* the idea has to be concretised into *processes* or *products*. *Processes* associated with “teaching for creativity” may be related to the ways of teaching and learning. Examples of such *processes* include providing choices for students to select a topic of investigation for their assignments and allowing students to have various ways to express their learning i.e., through writing, music, arts and other means according to the students’ preferences. When the *concept* of “teaching for creativity” is materialised into a *product*, it may be in the form of a creative-enhancement programme where students could participate to develop their creativity. It may also be in a form of a policy that serves as an institution’s blueprint to guide decisions and processes or protocol for “teaching for creativity”. In general, any outcome resulted from a creative act may be a *concept, process*, and/or *product*.

5.2.1.6 Value Proposition – Values of the Creative Outcome

Any creative outcome, whether it is a *concept, process* or *product,* has a value. The Value proposition captured features that gauge the significance or impact that the creative outcome brings. These features are significance or impact that were relevant to the individual themselves (*person-centered*), the individual’s peers (*immediate context*), the *wider community*, the individual’s *professional community*, and the world through evolutionary (*global – evolutionary*) and revolutionary impacts (*global – revolutionary*). Each of these features could be seen as a result of a specific strategy (Cohen, 1989; Sternberg, 1999).

The "*person-centered*" value is defined as the personal value that a creative outcome brings to the creator or problem solver. This feature recognises the creative attempts in learning through personally interpretating experiences, actions and events (Beghetto & Kaufman, 2007). When the value of a creative outcome is person-centered, what one creates might not be necessarily meaningful or impactful to the others, but it is meaningful to the creator. Previous studies have suggested that a creative outcome that gives a personal value to the creator is usually achieved through the replication of existing solutions (Cohen, 1989, 2012; Taylor, 1975). An outcome with a personal value usually solves day-to-day problems faced by the problem solver. For example, when the doctor uses surgery to treat organ failure, the doctor is solving a day-to-day problem. This solution may be meaningful to the doctor themselves, but to other doctors, it may not be perceived as novel or impactful.

Within the "*immediate context*" value, the creative outcome is of value to the creator or problem solver and may also be seen as meaningful or impactful by the others such as their peers or colleagues. A creative outcome that is valuable to the creator and others is usually achieved through the imitating or modelling after existing solutions (Cohen, 1989, 2012). This outcome usually solves day-to-day problems faced by the problem solver and/or the others. From the example of a pacemaker and dialysis machine, this solution would be meaningful to the creator themselves, and may also be appreciated by others, probably those who were involved in the field of cardiology and nephrology.

Within the "*wider community*" value, the creative outcome is valued by a wider community. An outcome that brings significance appreciated by the wider community can usually be generated through the *Transfer* strategy (Cohen, 1989). The outcome usually solves problems shared at a community level. Using the development of chemotherapy as an example, the development may have a wider impact to a particular community – this community may be those involved in the field of medical and cancer therapy.

The "*professional community*" value denotes the significance or impact a creative outcome brings to the community in a particular field and moves the field forward from where it currently is. This outcome can usually be generated through the *Characterise* strategy (Sternberg, 1999). For example, the development of targeted therapy brings value to the professional community i.e., the medical community. However, targeted therapy advances the knowledge of cancer therapy and forwards this knowledge for further development. For instance, targeted therapy developed growth signal inhibitors, drugs that induce apoptosis and endogenous angioinhibitors (Sudhakar, 2009).

The "*global-evolutionary*" value highlights the evolutional impact that the creative outcome contributes to the world. This outcome is not yet revolutionary. The global-evolutionary impact is usually generated through the exercise of the *Transform* strategy i.e., integrating ideas from various disciplines (Cohen, 1989, 2012). This outcome usually solves global problems. For example, the organ transplant solution has an impact globally as it has moved from transplanting solid organs such as kidney, heart and liver to face, hand, uterus, that aim at improving the recipient's quality of life.

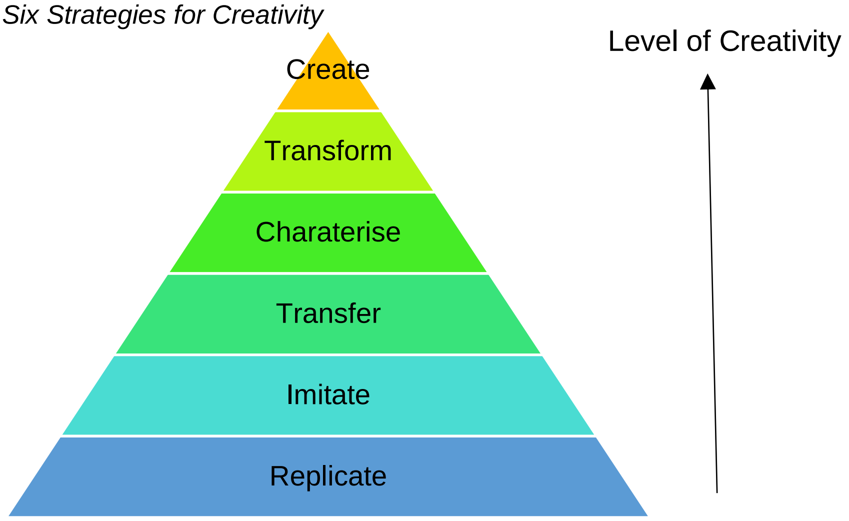
Like the "*global-evolutionary*" value, the "*global-revolutionary*" value has a global value, but accentuates the revolutionary impact because an outcome that has a "*global-revolutionary*" value brings a radical change to the world. This impact is usually achieved through the *Create* strategy (Cohen, 1989, 2012; Sternberg, 1999). This outcome addresses global problems or situations. Cloning is an example that created a shift of paradigm in the medical field.

5.2.2 The Presentation of the 24 Features on the Taxonomic Framework for Creativity

The 24 features from the five propositions are presented based on the three segments i.e., (i) the creative actions (strategies) i.e., the use of strategies (*Replicate, Imitate, Transfer, Characterise, Transform* and *Create*), (ii) the factors facilitating the use of strategies, and (iii) the results of the use of strategies. To illustrate the creative actions, I presented the six strategies in a pyramid to show the varied degrees of complexity and creativity underlied in each strategy. The pyramid is displayed as Figure 5.4.

Figure 5.4

Six Strategies for Creativity



The framework acknowledged that the degree of complexity and creativity of these strategies increases from *Replicate* to *Create*. However, the degree of complexity and creativity of each strategy did not determine the importance of these strategies. For example, although the framework assumed that certain strategies like *Transform* and *Create* may produce outputs that have a wider significance than other strategies like *Replicate* and *Imitate*, none of these strategies was deemed more important or valuable than the other. Equal importance was given to all strategies because every problem may need to be resolved using different strategies. Previous studies have shown that creative individuals who experience failure in problem solving restructured their mental representation i.e., using productive thinking, to finally address the problem (Fleck & Weisberg, 2004; Weisberg & Suls, 1973). This framework therefore aimed to provide a list of strategies that act as a guide for problem solving, from ones that exercise more reproductive thinking to ones that exercise more productive thinking. If one strategy fails to solve a problem, the individual may attempt other strategies to address the problem. The framework did not propose or prescribe a particular process in applying the strategies.

To illustrate the factors that aid the application of the six strategies, I presented the factors in the form of a checklist as shown in Figure 5.5 below ("Check yourself" section). The checklist reflects tacit knowledge from the Mental proposition i.e., *person, task* and *strategic knowledge*, intuition from the Mental proposition i.e., *intuitive ideation* and *intuitive evaluation, motivation, openness,* and *risk-taking* from the Trait proposition, and *resources* from the Context proposition. This checklist was meant to be applicable for all the six creative strategies. Each factor in the checklist was represented by an "I can" statement. These statements were meant to help educators and students understand the thinking processes, emotional states and contextual conditions required to develop creativity, how they will be expected to be creative and what they need to do in order to demonstrate creative acts. These statements in the checklist could also be used by educators to support the development of creative acts.

The expected results of the use of each strategy are presented in an infographic diagram in Figure 5.5 (next to the “Check yourself” section). Figure 5.5 presents the infographic for *Replicate* (see APPENDIX B for infographics of the entire prototype taxonomic framework). The infographic is sequenced by first providing the definition of the strategy, followed by presenting the outcome of applying the strategy (Outcome proposition), explaining the value or impact of the creative outcome (Value proposition), and finally an example to illustrate the strategy. To allow potential users to grasp the comprehensive features of creativity, I presented each strategy with an infographic (definition, outcome, impact and example) and the generic factors (checklist) next to each other, as shown in Figure 5.5.

Figure 5.5

Presentation of the Taxonomic Framework

Replicate

What is it?

To reproduce in the identical image of the existing product or solution to address an identical or similar problem or situation.

The replication is by way of the:

(1) adoption of an existing product or solution, or

(2) in parts, the form, idea and/or processes of the product or solution.

What is the outcome? } Outcome

The solution can be a concept, process and/or product.

What is the impact? } Value

The product or solution:

- addresses personal problems
- is valuable to the problem solver
- solves common day-to-day problems.

Example

Problem: Organ failure

Solution: Using surgery to remove the affected area of the organ

Explanation: The use of surgery has long existed, and therefore if this way is used to solve the problem (treat organ failure), there is very low innovation in the solution.

Check yourself:

Check yourself	
❑ I know the strengths I have to solve this problem. ❑ I know the limitations I need to overcome in solving this problem.	Mental: tacit knowledge (person knowledge)
❑ I know the problem that needs to be solved. ❑ I know the underlying causes of the problem. ❑ I know the steps to solve the problem. ❑ I know the knowledge I need to better understand the problem.	Mental: tacit knowledge (person knowledge)
❑ I know why I want to use this strategy to solve this problem. ❑ I know the existing products or solutions that I can adopt or adapt.	Mental: tacit knowledge (strategic knowledge)
❑ I can judge if the way I play with the idea can solve the problem. ❑ I can judge if the product or solution I produce can solve the problem.	Mental: intuition (intuitive ideation) Mental: intuition (intuitive evaluation)
❑ I am motivated to solve this problem. ❑ I am open to new possibilities. ❑ I try to produce many solutions without worrying about right or wrong. ❑ I try to use whatever resources available to me.	Trait: motivation Trait: openness Trait: risk-taking Context: resources

Placing all the propositions (infographic and checklist) on the same page for the explanation of each strategy intended to provide users with a reminder of all the propositions for creativity, and to help them ensure all the factors – cognitive, affective, and contexts are activated when engaged in any creative endeavours.

5.3 Discussion

Using a systematic synthesis of theories, frameworks and research on creativity through a thematic analysis of the creativity features reported in the literature, this first phase of my study developed a prototype taxonomic framework to understand, describe and develop creativity from multiple dimensions reported in the literature. Unlike previous frameworks that largely present a list of factors that affect creativity, the resulting prototype taxonomic framework of this study consisted of 24 key features of creativity that were distributed over five propositions i.e., *mental* (mental processes), *trait* (personality trait), *context* (environment), *outcome* (types of the outcome) and *value* (impact of the outcome) for the higher education context. The thematic analysis of the identified creative features offers a novel way of understanding how the five propositions of creativity are connected with each other. This section presents the discussion related to the research question of this phase of the study i.e., *what are the features that make up the prototype taxonomic framework for creativity through a synthesis of the literature?* The discussion will be organised into three areas i.e., (i) creative strategies as part of the Mental proposition, (ii) factors supporting the exercise of creative strategies and (iii) creative outcomes and values as a result of the application of creative strategies.

5.3.1 Creative Strategies as Part of the Mental Proposition

The creative strategies i.e., *Replicate, Imitate, Transfer, Characterise, Transform* and *Create* involve a series of thinking processes aimed at consciously developing solutions to solve problems or explain complex situations. These strategies, from *Replicate* to *Create* organised in a continuum in ascending order of complexity and creativity, mirrored the concepts of reproductive and productive thinking highlighted respectively in the Associationist and Gestalt theory. The arrangement of the strategies in the continuum concurred with Sternberg's (1999) assertation that some problem solving relies on existing solutions, but some require certain levels of novelty to enhance the original solutions. This accentuated that the choice of strategies depends on the problem. The framework did not assign specific significance to any of the strategies – every strategy is equally important. These strategies can be applied individually and collaboratively in groups. In the teaching and learning context, the organisation of the strategies in a developmental manner would allow creative acts to be scaffolded. These strategies aimed to assist educators in identifying the skill gaps in students' creative behaviours to design activities that support students to develop creative thinking. Educators could use these strategies as a guide in formulating learning outcomes for teaching creativity, teaching for creativity and teaching with creativity. The strategies may also serve as a basis for developing curricula, instructional techniques and assessment for creativity.

5.3.2 Factors Supporting the Exercise of Creative Strategies

The exercise of the six creative strategies is supported by the interaction among individuals' *mental* processes (Mental proposition), personality *traits* (Trait proposition) and *contextual* factors (Context proposition) by which an individual or group produces solutions. The intertwining relationship between the Mental, Trait and Context propositions was in consistent with Amabile's (1982) Componential Model of Creativity and Sternberg and Lubart's (1991) Investment Theory of Creativity, which emphasise the interplay between one's thinking processes, dispositions, and the environmental conditions to invoke creativity. Through the mental proposition, the framework placed an emphasis on harnessing the power of intuition in both generating and evaluating solutions. This was because intuition is necessary in addressing ill-defined problems (Khatri & Ng, 2000). With the framework, educators and students could be prompted to understand themselves, the task and the "how" and "why" of each strategy in solving a problem (*tacit knowledge*), as metacognition has been demonstrated to be effective in facilitating creativity (e.g., Erbas & Bas, 2015; Zheng et al., 2011).

Through the Trait proposition, the framework emphasised the individual's intrinsic desire to solve a problem (*motivation*). In the context of teaching and learning, this could serve as a reminder for educators to ensure the problems used in the classroom are authentic and relevant to the students. These problems should be ones that allow for multiple solutions without any expected routes to the solutions (Neber & Neuhaus, 2012). With the focus of *openness* and *risk taking*, educators would be expected to not only encourage but also demonstrate these traits in the process of teaching and learning. With regards to the environmental factors (Context proposition), although features such as supportive leadership, adequate facilities, sufficient time and adequate financial support are important conditions for creativity (e.g., Amabile et al., 1996; Jaiswal & Dhar, 2015), what is found to be more important from the findings is the ability to identify opportunities in the environment. Therefore, instead of putting an all-inclusive list of context-related features, I focused on the ability to use available resources to highlight the need for recognising opportunities in every context.

Aligning with the position of this study that creativity can be taught and learned, the Mental, Trait and Context propositions served as a guide for educators and students to understand the various components necessary for a creative attempt to occur. The Mental, Trait and Context propositions captured in the checklist allowed both educators and students to analyse whether they are equipped with the capacity to be creative, whether they are instilled with the right beliefs and attitudes to be creative, and whether they have identified opportunities that supported them to demonstrate creativity. For educators, these three propositions prompted them to analyse if they have created activities for students to exercise those capabilities, whether they have the right beliefs and attitudes about teaching and learning creativity, whether they attempt to instill those beliefs and attitudes in students, and whether they provide students with a conducive environment for creativity.

5.3.3 Creative Outcomes and Values

The use of creative strategies, supported by factors related to the Mental, Trait and Context propositions would yield a creative outcome. A creative outcome can be manifested in the form of a *concept, process* and *product* (Outcome proposition). The Outcome proposition was a crucial gap that this framework attempted to address. The features outlined in this proposition i.e., *concept, process* and *product* helped define creative outcomes, and placed importance in materialising creative ideas, instead of leaving ideas as abstract thoughts themselves. The purpose of the Outcome proposition was two-fold. First it helped in identifying whether an outcome is an abstract *concept*, or a concrete *process* or *product*. Second, it encouraged creativity not just in the idea-creating sense, but also in the action-producing sense i.e., to put ideas to work in reality. In the context of teaching and learning, developing the ability to identify the types of outcomes – whether they are *concepts, processes* and/or *products* could guide individuals towards producing a prototype of their solutions, which is one of the key phases in creative problem solving (e.g., Atlan & Tan, 2020).

Every creative outcome contains a value (Value proposition). The features of the Value proposition mirrored existing views towards the results of creativity (Boden, 2004; Kaufman & Beghetto, 2009). This proposition helped recognise the impact of the creative outcome an individual or group produces. More importantly it helped educators and students to acknowledge the personal and developmental aspects of creativity. It helped demystify the myth that creativity is merely about one that revolutionalises a field. Concurring with Cohen's

(1989) and Sternberg's (1999) assumptions, this study presumed that the level of significance of a creative outcome may be resulted from the use of specific strategies. Each feature in the Value proposition was therefore in parallel to a specific creative strategy. For example, *Replicate* reproduces an outcome that is novel or useful to the creators themselves, but may not necessary be novel and useful to the others.

In sum, previous studies in creativity have foreshadowed most of the features that emerged in the taxonomic framework. The prototype taxonomic framework represented the first step towards a common language for understanding, developing and assessing creativity in higher education. It could allow educators and students to consider creative actions, factors and results of creativity. Moreover, it also presented a framework in which previous theories, concepts and research on creativity may be situated, and at the same time, pointed to aspects of creativity that may need further clarification and investigation.

5.4 Conclusion

In conclusion, the 24 features captured through the five propositions in the taxonomic framework portray the multifaceted nature of creativity that can be activated and implemented. Ultimately, it is unlikely that the framework has captured all-inclusive features of creativity. Rather, a taxonomic framework like this can help educators and students expand their thinking about what creativity is and entails, and how it can be operationalised in teaching and learning.

This prototype taxonomic framework had weakness and ambiguities. First, the prototype was developed based on my own interpretation of the literature. The subjectivity involved in developing the framework may not have appropriately and comprehensively incorporated features of creativity into the framework. The examples used to exemplify each strategy may not be ones that were perceived understandable due to individual differences. Second, the framework was new and conceptual, which had yet to be examined. It was therefore unknown if the features integrated in the framework were relevant from the educators and students' perspectives. More importantly, it was inappropriate to assume the usefulness of the framework in facilitating creative behaviours. In view of these limitations, the prototype framework would be examined in the subsequent phases. It would first be examined by students and lecturers across various disciplines through the use of a survey, followed by on-one-one interviews with participant-nominated creative students and lecturers, and finally a problem-solving task with a group of students. The next chapter will discuss findings of data collected from the survey.

CHAPTER SIX

PHASE II: The Survey

6.1 Introduction

Following the first phase of my research, which was the development of a prototype taxonomic framework for creativity, I developed it further through refinement based on empirical data collected from students and lecturers through three other phases of my study. The second phase, which is the focus of this chapter, aimed to achieve two objectives through a survey. The first objective was to explore the understanding of creativity from higher education students and lecturers from the context of the study. This group of participants are termed the reference population in my study. The second was to obtain the reference population's feedback on the relevance of the strategies and the taxonomic framework. The findings from this phase were used to address research question two of this study, i.e., *what are the perceptions of the reference population on creativity and the relevance of the taxonomic framework?*

6.2 Methodology

This phase employed a mixed-method design through the use of an open-ended survey.

6.2.1 Demographic Details of the Participants

The survey was completed by 334 second year undergraduate students and 105 lecturers at the university. The sample is referred to as the reference population in this study, because it comprised students from all disciplines at the university, (Science, Arts and Social Sciences, and Engineering) and both student and lecturer participants. The demographic data for the reference population is presented in Table 6.1. There is, as far as possible, equal representation of participants from each faculty.

Table 6.1

Demographic Data of the Reference Population

Faculty	Arts and Social Sciences	Science	Engineering
Disciplines	• Business • Centre for English Language and Foundation Education • Division of Organisational and Applied Psychology • Economics • Education • English • Media, Languages and Cultures	• Biomedical Sciences • Biosciences • Computer Science • Environmental and Geographical Sciences • Pharmacy • Psychology	• Applied Mathematics • Chemical and Environmental Engineering • Civil Engineering • Mechanical, Materials and Manufacturing Engineering
Total number of participants	Students: 94 Lecturers: 40	Students: 111 Lecturers: 32	Students: 129 Lecturers: 33
Malaysian	Students: 60 Lecturers: 23	Students: 61 Lecturers: 17	Students: 79 Lecturers: 23
Non-Malaysian	Students: 34 Lecturers: 17	Students: 50 Lecturers: 15	Students: 50 Lecturers: 10

The reference population was made up of a mixture of Malaysian and non-Malaysian. Non-Malaysians include participants from Singapore, Mauritius, Maldives, United Kingdom, Japan, Nigeria, Italy, Spain, Indonesia, Vietnam, India, Korea and China. Student participants comprised 59.88% Malaysians and 40.12% non-Malaysians. Lecturer participants comprised 60% Malaysians and 40% non-Malaysians. The second-year students were chosen because they would have had one year of undergraduate experience in the university thus, they would have gained familiarity with university-level skills and expectations, and therefore would be able to review my framework using their university experiences.

To invite lecturers to participate in this study, I first sent an email through each faculty to all lecturers. Once I received an email from lecturers who indicated an interest in taking part in my study, I personally approached these lecturers via email to give them an overview of my study and the objective of my survey. I then distributed my survey only to lecturers who agreed to participate in my study. After a week, I sent them a reminder about completing the survey. To collect data from the students, I sought permission from lecturers of each discipline to organise a 30 to 45-minute session for me to conduct my survey with their students. During these sessions with the students, I explained the objective of the survey and clarified the questions to ensure they fully understood each question and were clear of what was expected of them. I also informed them that they were not obliged to complete the survey.

The identity of the participants are anonymised using the following labels to indicate if they are a student or a lecturer, and the disciplines they are from: S refers to students; L refers to lecturers; SA refers to students from Arts and Social Sciences; SS refers to students from Science; SE refers to students from Engineering; LA refers to lecturers from Arts and Social Sciences; LS refers to lecturers from Science; LE refers to lecturers from Engineering. Each individual participant was assigned a number. These labels will be used in the presentation of findings later in this chapter.

6.2.2 Research Instrument

This phase used a survey entitled “Assessment of the Taxonomic Framework for Creativity” (see APPENDIX C), which was constructed based on the prototype taxonomic framework presented in Chapter Five. The survey questions focused on (i) exploring the meaning of creativity understood by the participants and (ii) evaluating the relevance of the strategies and the taxonomic framework. There were two sections in this survey – the first section required participants to complete the survey without reference to the taxonomic framework; the second section required participants to compete the survey with reference to the taxonomic framework. The first section comprises one open-ended and one close-ended questions. The second section comprises eight open-ended questions. This survey comprises mainly open-ended questions to obtain elaborate responses from the participants using their own knowledge, understanding and feelings of creativity.

In the first section, the first question required the participants to explain their understanding of the term “creativity” by explaining what it is. After that, the participants were presented with the six creative strategies (a) *Replicate*, (b) *Imitate*, (c) *Transfer*, (d) *Characterise*, (e) *Transform* and (f) *Create*, in random order. They had to rank the randomly ordered six creative strategies in the framework according to the level of creativity (1 being least and 6 being most creative). By requiring participants to order these creative strategies, I intended to find out if the order of the strategies in my prototype taxonomic framework corresponded to their understanding of the complexity of the strategies.

In the second section, participants were shown the taxonomic framework and required to answer the questions by referring to it. In this section, they were asked to first compare their order of the six creative strategies with mine, and consider which order, theirs or mine was more appropriate. They were asked to justify their opinions. Then, they were asked to comment if the taxonomic framework (i) reflected the range of strategies involved in creativity,

(ii) was useful for understanding and developing creativity, (iii) was easy to understand and (iv) was user-friendly. They were also asked to (i) suggest uses for the taxonomic framework, (ii) highlight limitations of and concern about the taxonomic framework and its functions and (iii) provide suggestions to improve the taxonomic framework.

At the end of the survey, participants were asked to nominate a creative lecturer and a creative student and provide justifications for their nomination. Their responses would help me access their understanding of creativity through their descriptions of a creative individual, and to help me select participants for the next phase of my study. As this study intended to explore how creativity is understood by lecturers and students from all dimensions, I did not set any parameters for the participants' nominations.

6.2.3 Pilot Study of the Survey

A pilot study was conducted to assess (i) the data collection protocol and (ii) the suitability of the survey questions with the potential participants. Based on Connelly's (2008) guidance, the number of participants involved in the pilot studies were 10% of the estimated sample size for my actual study. Thus, the pilot study for the survey involved 30 participants (20 students and ten lecturers). With regard to the data collection protocol, initially, I intended to get students to answer each question on the survey at the same pace. However, during the pilot study, I found that students completed each question at different rates and my approach caused discomfort to students who wanted to complete the survey questions at a slower rate. Therefore during the actual study, I explained the aim of the research and allowed students to complete the survey questions according to their own pace within 30 to 45 minutes. I also was present throughout the data collection process to ensure they were allowed to ask questions if they were unclear of any questions in the survey. Additionally, the pilot study also allowed me to identify and rectify questions that might cause misunderstanding among students. As a result, I simplified the sentence structure of some of the survey questions. For example, I revised the question "in your opinion, in what ways you would apply this framework?" to "how would you use a framework like this?". Out of ten questions, I retained seven questions, and only three questions were rephrased based on the feedback obtained from the pilot study.

6.2.4 Data Analysis

6.2.4.1. Data Analysis for Open-Ended Questions

I used thematic analysis guided by Braun and Clark (2006) to interpret and derive themes from my participants' verbatim responses to the open-ended questions. The thematic analysis process is outlined in Table 6.2. These steps were not a linear process, but a recursive process throughout the analysis. Once the data had been recorded, I immersed myself in the data to familiarise myself with each participant's responses. Then, I labelled the participants' responses with codes to represent their understanding of creativity and their perception of the strategies and framework for further analysis and interpretation. When generating the codes, I used my broad understanding of creativity instead of the concepts developed for my taxonomic framework to reduce bias.

Table 6.2

Thematic Analysis Process

	Steps	Description of the Steps
1.	Familiarising with the data	Transcribing data, read and re-reading the data, taking down initial ideas.
2.	Generating codes	Coding interesting and relevant features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3.	Searching for themes	Collating codes into potential themes, gathering all data (extracts) relevant to each potential theme. Different categories of themes may emerge.
4.	Reviewing themes	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic "map" of the analysis.
5.	Defining and naming themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6.	Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research questions and literature, producing a scholarly report of the analysis.

After generating the codes, I collated these codes into predetermined themes presented in Table 6.3. The predetermined themes were guided by the three main areas of investigation i.e. (i) definition of creativity (concept of creativity and creative individuals), (ii) relevance of the strategies, and (iii) relevance of the taxonomic framework.

Table 6.3

Predetermined Themes for Data Analysis

Areas of investigation	Definition of Creativity	Relevance of the Strategies	Relevance of the Taxonomic Framework
Themes	• Mental • Trait • Context • Outcome • Value	• Perceptions of the order of strategies • Reflection of creative strategies • Modifications	• Potential for facilitating understanding and developing creativity • Comprehensibility • User-friendliness • Potential uses • Areas of concern

For codes related to the definition of creativity (concept of creativity and creative individuals), I collated the codes and assigned them according to the five propositions of creativity developed in this study i.e., mental, trait, context, outcome and value, to understand how the participants viewed these propositions of creativity. The operational definitions of the propositions in my taxonomic framework are:

- *Mental* proposition – refers to the use of mental processes (cognitive, metacognitive and affective processes) to support or invoke creativity.
- *Context* proposition – refers to determining if the creativity is bound by specific contexts (social, physical, and disciplinary) or independent of any context.
- *Outcome* proposition – refers to the results of the creative output, i.e., whether the outcome is an *idea, process* or *product*, or a combination.
- *Value* proposition – refers to the significance of the creative outcome to the creator(s). Value is ascertained by distinguishing if the novelty and usefulness is person specific, i.e., new and useful only for the person, or historically original and useful, i.e., never done or achieved before, and new or useful for the world.
- *Trait* proposition – refers to the individuals' personalities, qualities and characteristics that invoke creativity, e.g., open-mindedness, risk-taking.

Very importantly, I also made sure that I took note of codes that did not reflect any of the five propositions. However in this phase, all the codes fitted the propositions in my prototype taxonomic framework. Here is an example of how codes were generated, then assigned to a predetermined theme (propositions) or to a theme that does not relate to the propositions:

> *Creativity is to <u>break old thinking</u>, <u>connect ideas</u> and those final ideas will be <u>outside the box</u>.* (SS 9)

In the above example, I coded three core meanings of creativity. Firstly it refers to creativity as being productive thinking (i.e. "*break old thinking*"). Secondly it refers to making connections among ideas (i.e., *"…connect ideas*"). Thirdly it refers to the outcome as being innovative, or innovativeness (i.e., *"…those final ideas will be outside the box"*). As *Productive thinking* implies the process of shifting or changing conventional perspectives; I therefore assigned it to the Mental proposition. *Making connections* denotes the process of connecting ideas; therefore it was also assigned to the Mental proposition. *Innovativeness* suggests the significance of the outcome; therefore it was assigned to the Value proposition.

With regard to the relevance of the strategies in the taxonomic framework, there were three predetermined themes: (i) perceptions of the order strategies, (ii) perceptions of whether the strategies presented were relevant to creativity, and (iii) proposals for modification. With regard to the relevance of the taxonomic framework, there were five predetermined themes for the relevance of the framework: (i) the framework's potential for understanding and developing creativity, (ii) the comprehensibility of the framework, (iii) user-friendliness of the framework, (iv) potential uses of the framework and (v) areas of concern about the framework. Similarly, codes that do not fit into these themes would be taken note of; however in this phase, all the codes fitted the pre-determined themes.

Upon assigning the codes to themes, I reviewed the themes and the codes to ensure a close fit between the meaning of the codes and themes. I revisited the data to check, recode the information where necessary, and looked for more evidence. This was an important process as the relationship between codes and themes should be repeatedly confirmed to ensure the findings were trustworthy (Braun & Clarke, 2006). Finally I defined each theme based on the key idea that each theme captured from my data. To further understand which views were more predominant and which were less among the participants, I also did a frequency count of codes for each theme. The count was then converted into percentage.

To ensure reliability of the analysis, after the coding of data was completed, following the inter-coder protocols of past studies using thematic analysis (e.g., MacPhail et al., 2015; O'Connor & Joffe, 2020), 10% of the completed surveys i.e., responses from 30 students and 10 lecturers were also given to another coder, who is an academic with expertise in creativity from another university. The inter-reliability coder coded the survey responses, and assigned them to themes using the same process that I used (Step 1 to Step 4) presented in Table 6.2. The Cohen's Kappa test was used to determine the level of agreement in the codes derived by me and the coder. According to Cohen (1960), the Kappa value within the range of 0.81 to

1.00 is of good level of agreement. There was good level of agreement between our interpretation, k=.81.

6.2.4.2 Data Analysis for Closed-Ended Question

To analyse data gained from the closed-ended item i.e., the order of the six creative strategies assigned by the participants, I used the Friedman test. Friedman test was used because the data in this study fulfilled the highlighted assumptions. According to Field (2018), the Friedman test compares differences between variables (strategies) measured from the same participants (each participants ranked each strategy) and the variables are measured using ordinal data (the strategies were rated as a rank of 1, 2, 3, 4, 5, or 6). The rank of “6” is assigned to the perceived most creative strategy and “1” is assigned to the perceived least creative strategy. There were no tied ranks in the data, which means that each strategy was given a distinct value. The Friedman test has been commonly used to compare and analyse preference and ranking data in past studies involving sensory evaluation of fried snacks (Senthil et al., 2002), preference for major connector designs in dentistry (Pallegama et al., 2006) and food tasting (Jaeger & Cardello, 2009; Jaeger et al., 2008).

The ranking of each strategy was determined based on the rank sum, and mean rank value. The rank sum is the sum of ranking while the mean rank value is the average of the ranking. When statistically significant X value was identified from the Friedman test, I did a post-hoc analysis with the Wilcoxon signed-rank test. To prevent Type 1 error, I adjusted the α of Wilcoxon signed rank using Bonferroni adjustment method (.05/6). If the Wilcoxon signed-rank test shows a statistical significance between a pair of strategies, it means the two strategies’ ranks are significantly different from each other. If the Wilcoxon signed-rank test does not show a statistical significance between a pair of strategies, it means the two strategies’ ranks have been perceived as similar by the participants. The null hypothesis of this part of the study was that all the strategies did not differ significantly with respect to the level of creativity.

6.3 Findings

In the section below, I will present the findings according to three areas: (i) definitions of creativity, (ii) relevance of the strategies, and (iii) relevance of the taxonomic framework perceived by the participants.

6.3.1 Participants' Definitions of Creativity

In the open-ended survey, I elicited participants' definitions of creativity from two perspectives, which is to (i) define creativity as a concept and (ii) justify their criteria for nominating a creative lecturer or a creative student.

6.3.1.1 Definition of the Concept of Creativity

To understand which propositions were mentioned the most by the participants, a frequency count of the occurrences of each code in each proposition was tabulated. In some cases, a participant's definition of creativity may be assigned one or more than one codes. When there were more than one code, the codes could be assigned to only one proposition or assigned to two or more propositions. For example, "*creativity is about making connections and breaking old conventions*" (SA 1). This definition contains two codes i.e., *making connections* and *breaking old conventions,* and both codes refer to the Mental proposition. This definition is regarded as single dimensional because it only refers to one proposition. In another example, "*creativity is to think from different perspectives to produce something new"* contains two codes i.e., *divergent thinking* (think from different perspectives) and *novelty* (something new). This definition is two-dimensional because it refers to two propositions i.e., Mental (divergent thinking) and Value (novelty). Altogether, a total of 1129 codes were generated from the 334 student participants' definitions of creativity, and a total of 458 codes were generated from the 105 lecturer participants' definitions of creativity. The majority of the participants, 130 students and 38 lecturers produced single dimensional definitions of creativity while the other participants produced multidimensional definitions.

Table 6.4 displays the frequency count of codes that represent the participants' definitions of creativity according to the five propositions developed in the taxonomic framework. I present data from all three disciplines collectively because I did not find major differences in the definitions offered by the lecturers and students from each discipline. Table 6.4 shows that Value is the most frequently mentioned proposition by both students (56.86%) and lecturers (55.46%). Value is followed by Mental (S=33.12%; L=33.40%), Outcome (S=7.53%; L=7.86%), Context (S=1.59%; L=2.62%), and Trait being the least mentioned by both students (0.88%) and lecturers (0.66%). It is interesting to note that the priority given to the propositions was the same for both students and lecturers.

Table 6.4

Definitions of Creativity Offered by the Participants

Proposition	Students' definitions, S		Lecturers' definitions, L	
	Percentage of codes (no. of codes)	Percentage of students (no. of students)	Percentage of codes (no. of codes)	Percentage of lecturers (no. of lecturers)
Value	56.87% (642)	84.13% (281)	55.46% (254)	74.29% (78)
Mental	33.12% (374)	66.17% (221)	33.40% (153)	62.86% (66)
Outcome	7.53% (85)	25.45% (85)	7.86% (36)	34.29% (36)
Context	1.60% (18)	5.39% (18)	2.62% (12)	11.43% (12)
Trait	0.88% (10)	2.99% (10)	0.66% (3)	2.86% (3)

Note. Total student codes=1129; Total lecturer codes=458
Total no. of students=334; Total no. of lecturers=105
S=student; L= lecturer

The majority views of creativity among the participants were related to the Value and Mental propositions. In fact, the multidimensional definitions were predominantly a combination of the Mental and Value propositions. Value relates to the impact of the creative output. Within the Value proposition, participants predominantly associated creativity with the ability to produce outputs that are novel. A novel output can demonstrate *Innovativeness* or *Originality.* Novel output that is innovative are the ones that improve current solutions, thus unconventional. 113 students and 43 lecturers subscribed to this view.

> *Creativity is to produce something that has an upgraded and innovated level to it. (SE 28)*

> *Creativity is to come up with something out of the box. (LA 2)*

Novel outputs that demonstrate originality refers to those that are completely different from existing outputs. This view was expressed by 83 students and 20 lecturers.

> *Creativity is to be able to come up with something that is completely new – something that no one has done before.* (SS 13)

> *Creativity is to create something not existed before.* (LE)

Interestingly, five participants associated creativity with having a personal value i.e., personal creativity. This minority group emphasised that creativity is the generation of outputs that are only valuable to the creators themselves. Outputs are valuable when they demonstrate meaningfulness, usefulness and novelty. These perspectives can be seen from the quotes below:

Creativity is about things that are meaningful to that person. (SS 87)

Creativity is something useful for yourself. (SE 76)

Creativity is producing what you think suits you. (LA 23)

Creativity is bouncing off ideas that are new to you. (LS 43)

The Mental proposition refers to the mental processes that invoke creative behaviours. Within this proposition, creativity was mainly defined in relation to *Problem-solving*. Most participants (149 students and 41 lecturers) connected creativity with problem solving by highlighting the need for multiple solutions in addressing a problem. The quotes from two students and two lecturers below are examples that illustrate the problem-solving view of creativity:

Creativity is to produce many unusual solutions to problems. (SA 5)

Creativity is to solve problems with different ideas. (SS 23)

Creativity is finding different pathways to solve a phenomenon. (LS 18)

Creativity is all about problem solving. (LE 8)

The participants who did not explicitly connect their definitions of creativity to problem solving mentioned a range of reproductive and productive strategies, such as modifying ideas and combining ideas. These views, expressed by 51 students and 18 lecturers are portrayed in the quotes below:

Creativity is modifying existing ideas. (SA 56)

Creativity is taking what is there and make some changes to it. (SE 49)

Creativity is being able to join different ideas together, sometimes maybe not related. (LS 7)

Creativity is combining ideas together to become one. (LE 11)

The first and second quotes (modification) reflected reproductive thinking and the third and fourth quotes (combining ideas) reflected productive thinking.

Furthermore, 18 students and 7 lecturers viewed that creativity is a result of the "aha" moment (Spontaneous). Viewing creativity as spontaneous means that it is a skill that cannot be deliberately triggered and taught.

> *Creativity happens naturally and it cannot be forced to happen.* (SA 83)
>
> *Creativity happens just at the moment. You can't really teach it because it does not come in a structured form.* (SE 111)
>
> *Creativity is spontaneous. It happens at the spur of the moment.* (LS 1)

Moreover, three out of the total of 439 participants offered a unique definition that views creativity as involving the mental process of materialising an idea into an actual form. This view stressed on the process of materalising ideas into something real:

> *Creativity is to turn something into reality to use it.* (SA 7)
>
> *Creativity is an initiative of turning or transforming completely new or imaginative ideas into reality…* (SE 6)
>
> *Creativity is to indulge in deep thinking process to turn creative ideas into reality.* (SE 94)

In general, although the definitions of creativity offered by both students and lecturers encapsulated the five propositions of creativity i.e., Mental, Trait, Context, Outcome and Value, creativity was largely associated with the impact of the creative output one produces i.e., whether it is innovative or original (Value proposition) and one's mental processes (Mental proposition). The less emphasis on the personality traits for creativity (Trait proposition), contextual conditions for creativity (Context proposition), and outcome of creativity (Outcome proposition) could be explained by a few reasons. First, in higher education, creativity is largely associated with the thinking processes and the observable results of a creative outcome. Second, the participants in this study were students and lecturers, In the teaching and learning context, cognitive thinking and results are usually prioritised; hence this may explain why the Mental and Value propositions appeared to be predominantly associated with creativity. The result may not entirely represent a lack of comprehensive understanding of creativity among the participants, as responding through a survey may have limited the space for elaboration of their responses. Additionally, a few different questions may be needed to prompt their conceptualisation of creativity from multiple perspectives. Therefore, I also investigated their beliefs about creativity based on their descriptions of creative individuals.

6.3.1.2 Participants' Conceptualisation of Creative Individuals

The participants' understanding of creativity was also examined from their description of creativity individuals, i.e., creative lecturers and creative students. The participants' expectations of creative lecturers and students would triangulate their definitions of creativity as a concept. To examine how participants associated creative individuals with the five propositions, I employed the same code assignment procedure for the definition of creativity as a concept. I counted the number of codes related to each proposition and the number of participants that produces these codes based on their corresponding propositions. Similar to the participants' definitions of creativity, I did not find apparent differences between the criteria highlighted in these three disciplines. I therefore present the findings from all three disciplines collectively.

6.3.1.2.1 Students' Criteria for Creative Students

Table 6.5 below presents the frequency of codes that represent the students' description of their peers who are creative. The criteria that the students used to identify creative students reflected all the five propositions. 129 students (38.62%) did not indicate their views. Students' definitions were largely single dimensional, with 5 definitions being two dimensional.

Table 6.5

Students' Identification of Creative Students

Proposition	Percentage of codes (no. of codes)	Percentage of students (no. of students)
Mental	31.16% (67)	27.80% (57)
Value	20.47% (44)	21.46% (44)
Outcome	19.07% (41)	20.00% (41)
Context	15.35% (33)	16.10% (33)
Trait	13.95% (30)	14.64% (30)

Note. Total no. of codes=215; Total no. of students indicated their views=205

The majority views of creativity among the students b were related to the Mental and Value propositions. The multidimensional definitions included a combination of the Mental and Value propositions, Mental and Outcome propositions, as well as Context and Outcome propositions. Unlike their conceptualisation of creativity where only Mental and Value were predominantly mentioned, their descriptions of creative students more evenly represented all the five propositions. This may be because students were able to relate to the concept of creativity concretely when it was associated with an individual's quality.

Within the Mental proposition i.e., the mental processes that invoke creative behaviours, students (38 of them) generally associated creative students with those who are able to engage in *Problem solving*. This view was in consistent with their definitions of creativity as a concept. The students' creativity in problem solving was exercised in both academic (e.g., assignments) and non-academic matters (e.g., club activities).

> *She always knows how to solve problems.* (SE 32)
>
> *I feel he always can think of something when our brains are stuck in group discussion*. (SA 19)
>
> *She is good at throwing ideas when there is group discussion for assignments and club activities.* (SS 74)

In the Value proposition i.e., the impact of the creative output, the ability to produce something *Innovative* and with a *Personal value* were highlighted. 30 students believed that creative students are those who can produce outputs that are *Innovative.* This again was in line with how they defined the term "creativity". These views are demonstrated below:

> *She produces something that is really out of the box.* (SA 78)
>
> *His ideas are always very unique.* (SS 78)
>
> *She comes up with ideas that I can't think of, and many can't think of. It always stands out.* (SE 103)

While the personal value of a creative output was rarely mentioned when they defined creativity, *Personal value* of a creative output i.e., personal creativity, was obvious when the students described other creative students. This view was highlighted by 14 students. A predominant value that emerged from the student data is the ability to formulate solutions that help with students' learning. Below are some quotes from students that reflect this view:

> *(He) uses different new ways like colourful notes that help him learn better.* (SS 50)
>
> *(She) creates comic strips for our the "European Union" module to help her memorise the history.* (SA 20)
>
> *(He) is good in using mind maps in every module to remember formulas and rules.* (SE 67)

The Outcome proposition refers to the types of creative outcomes produced. Within this proposition, most students (41 students) related to the types of creative products produced by their peers when describing their peers' creativity. The predominant view referred to the *Product*-based solutions generated by their peers. For example, a student from the Arts attributed a peer's creativity to the ability to produce unconventional pieces of drawing, with a piece of drawing being a concrete product.

> *Her actual drawings [product] are very mind-blowing*. (SA 9)

Another student from Engineering attributed a peer's creativity to the ability to produce creative *Concepts, Process* and *Products*.

> *Her FYP idea is good, and it is good until she creates the actual app. But some are good when they present the <u>ideas</u> [concept], but the <u>actual software</u> [product] becomes mediocre. Some ideas in the end can't be developed into any software or hardware. She always has full creative <u>SOPs and operations [process]</u> and all.* (SS 61)

The Trait proposition denotes to the personality traits that affect creative behaviours. Within this proposition, 20 students mentioned the quality of *Confidence* in creative students, as illustrated in the following traits:

> *I think she is very confident.* (SA 57)
>
> *He is very confident, always feel he can do things.* (SS 17)

The Context proposition refers to the contextual conditions that contribute to creativity. These conditions could be related to a particular subject or disciplinary area an individual is engaged in, and also the physical and social environments one is in. Within the Context proposition, the students seemed to believe that creativity resides mainly in the arts related subjects such as painting, drama and theatre. Consequently, they related individual's creativity to their ability to perform creativity in the arts domains. This view was expressed by 30 students. As shown in the quotes below, the students only attributed their peers' creativity to their artistic abilities:

> *She is very good in arts and she is very active in theatre.* (SS 6)
>
> *She pays the piano and violin very well, very talented.* (SE 76)
>
> *She is very artsy, can paint really well.* (SE 16)

While there were a number of studies that examined educators' beliefs about creative students (e.g., Craft et al., 2014; Horng et al., 2005; Jahnke et al., 2015), my study was the first that explored how *students* perceive their creative peers.

6.3.1.2.2 Students' Criteria for Creative Lecturers

Table 6.6 presents data related to how the students see their creative lecturers, with reference to the five propositions for creativity. Similar to the way they identified creative students, their identification of creative lecturers highlighted all the five propositions, with a large emphasis on the Mental (47.35%) and Value (43.05%) propositions. 63 students (18.86%) did not respond to this question. Out of 271 students, 240 students' definitions were single-dimensional, 15 students' definitions were two dimensional. Among the two-dimensional definitions, 8 definitions comprised the Mental and Outcome propositions; 7 definitions comprised the Mental and Value propositions.

Table 6.6

Students' Identification of Creative Lecturers

Proposition	Percentage of codes (no. of codes)	Percentage of students (no. of students)
Mental	47.35% (143)	47.23% (128)
Value	43.05% (130)	42.07% (114)
Context	3.64% (11)	4.06% (11)
Outcome	2.98% (9)	3.32% (9)
Traits	2.98% (9)	3.32% (9)

Note. Total no. of codes=302; total no. of students indicated their views =271

Students' descriptions of their creative lecturers corroborated with their definitions of creativity but not their descriptions of creative students. Findings revealed that the way lecturers engaged with students (Mental) and the impacts their creativity brings (Value) were the qualities more known and observable to the students.

In the Mental proposition, most students primarily recognised that creative lecturers possess high abilities of *Divergent thinking* in relation to teaching*, Making connections* and *Engaging students.* These perceptions were respectively highlighted by 46, 40 and 38 students. First, they expressed that creative lecturers are those who could teach using a variety of teaching strategies to ensure effective teaching. This finding aligns with the concept of *divergent thinking* i.e., the ability to come up with multiple ideas to address problem or achieve a goal (i.e., problems or goals related to teaching). Some examples that reflect this view are presented below:

She uses different ways to teach us, like sometimes she will use boardgame, sometimes use role-play and sometimes she just talks. (SE67)

He uses different activities in the class. He has so many ways to engage us in anything that he teaches. (SA 72)

One thing I like is he will teach in many ways. Most lecturers teach using the slides and just discussion, but he has different approaches to things, like getting us to do debates, using quizzes, Kahoot, and sometimes ask us to do a reenactment. (SS 21)

Additionally, the students also explained that creative lecturers used analogies to teach difficult concepts and relate concepts to real life contexts and experiences to help them relate the newly learnt concept to what already knew or the real-life context (*Making Connections*).

He is good at explaining things…Once he said the molecule is like China population. (SS 21)

He always describes things using very effective analogies to help us understand. (SA 43)

She has the best examples to describe things and the comparison she makes between things is enlightening. (SE 77)

Moreover, to the students, creative lecturers were also capable of *Engaging students* in learning through motivating and drawing students' interests to the topics taught.

I think because he tries to engage with us a lot. He will think how to engage with us and he will relate to us with our heated topics. (SA 14)

He engages our attention by telling us stories and motivates us. It always works. (SS 79)

In her class she makes it engaging by trying to discuss things that current youths like us are most interested in. (SE 102)

Divergent thinking, Making connections and *Engaging students* were not highlighted when students defined the concept of creativity and creative students. This maybe because when identifying creative lecturers, they were focused on the lecturers' creativity in teaching. Surprisingly, students rarely viewed engaging in *Problem solving* as an essential characteristic of a creative lecturer, although problem solving was seen as an important criterion when they defined creativity as a concept and described creative students.

This study discovered a unique criterion for creative lecturers mentioned by four students that was not highlighted in any previous studies. This criterion is *Innovating based on students'* *lead in teaching* (Mental proposition). This perspective was related to the mental adaptability of the lecturers based on the development during the lesson, instead of merely abiding to the lesson plan. Such flexibility, which at the same time has an inspiring value, was appreciated as a quality of a creative lecturer. Two examples of this criterion is reflected below:

> *His flexibility and ability to adapt the structure of his lectures to accommodate students' opinions and curiosity even if it can be sometimes be away from the original content.* (SA 71)

> *He is super adjustable and sometimes we talk about a topic, and he can make it so fascinating and inspiring, and I don't mind if it's totally unrelated to the actual topic he meant to teach us.* (SA 96)

In the Value proposition, students gauged lecturers' creativity by predominantly looking at *Innovativeness* and the ability to *Enhance understanding. Innovativeness* here refers to the lecturers' teaching methodologies being unconventional. This view was emphasised by 64 students.

> *I like the activities in his (the lecturer) classes. He always has something innovative in the class.* (SA 7)

> *The football academy is really something. It is so unique that I have never seen other lecturers doing this before.* (SS 16)

> *She has very non-typical teaching styles and we all love her classes.* (SE 91)

Enhancing understanding which refers to whether the lecturers' teaching methodologies aid students' understanding. *Enhancing understanding,* highlighted by 53 students, is specifically associated only with creative lecturers' characteristics, and not mentioned by the students when they defined creativity and creative students.

> *Her explanation of things is clear – like it really helps us understanding some very complex kind of concepts.* (SE 5)

> *I think he is creative because he always can make us understand things very easily.* (SA 46)

> *She has her way of making things understandable. I can catch whatever theories or practical she tries to explain.* (SS 24)

In general, although *Originality* was prioritised when students defined creativity, it was not prominent when they identified creative lecturers. This suggested that when students defined creative lecturers, it is not important whether the lecturers' creative output is entirely new. Instead, their concern was whether the lecturers' pedagogy is varied, unconventional, engaging and enhances understanding. This could also mean that the students seemed to relate lecturers' creativity to their ability to teach creatively i.e., teaching with unconventional methodology to ensure effective learning that engages student learning and enhances student understanding. The importance was placed on effective learning rather than the nurture of creative thinking.

6.3.1.2.3 Lecturers' Criteria for Creative Students

Only 33 lecturers (31.43%) nominated a creative student and a creative lecturer, a big contrast to the 205 (61.38%) students who nominated a creative student, and 271 (81.14%) students who nominated a creative lecturer. Lecturers who did not nominate a creative lecturer and a creative student provided the following reasons for their decision: (i) data protection, (ii) they were new to the university, (iii) inability to identify creative students because they taught large classes; (iv) they did not know anyone who is creative. As less than half of the lecturers participating in this study nominated a creative student and a creative lecturer, it is important to note that the finding discussed below may not be not fully representative of the lecturers' criteria for creative individuals.

Table 6.7 below presents the lecturers' criteria for creative students with reference to the five propositions for creativity. The lecturers only related creative students to three propositions i.e., Mental, Value and Outcome propositions. The lecturers' descriptions were single dimensional. Only six lecturers described creative students from both the Outcome and Value's perspectives.

Table 6.7

Lecturers' Identification of Creative Students

Proposition	Percentage of codes (no. of codes)	Percentage of lecturers (no. of lecturers)
Mental	42.22% (19)	45.46% (15)
Value	40.00% (18)	30.30% (10)
Outcome	17.78% (8)	24.24% (8)
Trait	-	-
Context	-	-

Note. Total no. of codes=45; total no. of lecturers indicated their views =33

Their focus on the Mental and Value propositions when describing creative students paralleled their definitions of creativity as a concept. Some lecturers also related to students' creative work (whether it is an abstract *concept*, a *process* or a *product*) when describing creative students (Outcome proposition).

In the mental proposition, eight lecturers recognised *Critical thinking* and five lecturers recognised *Integrating ideas* as characteristics of a creative student. *Critical thinking* refers to the ability to conceptualise and analyse facts and arguments to form a judgment. This view is reflected in the quotes below:

> *She is a good critical thinker.* (LA 15)
>
> *He is quite creative because he has critical thinking.* (LS 26)
>
> *This student is very good at seeing things in analytically to make very informed judgement.* (LE 12)

Integrating ideas refers to the students' ability to connect and combine multiple ideas. This belief is demonstrated in the quotes below:

> *She combines a lot of literary devices and writing techniques in her narratives.* (LA 34)
>
> *She comes up with an interesting idea for her FYP (Final Year Project). She combines different ideas from all the semester's modules and her personal interest to form it (the FYP idea).* (LE 12)

Surprisingly, though most lecturers included *Problem solving* in their definition of creativity, they rarely highlighted it when recognising creative students.

In the Value proposition, although both *Innovativeness* and *Originality* of a creative output were major parts of the lecturers' beliefs about the concept of creativity, *Originality* was rarely mentioned (mentioned by two lecturers) when they identified a creative student. Instead, they highlighted *Innovativeness*. They (eight lecturers) largely appreciated the unconventional dimension reflected in students' work.

> *Her work is always very unconventional and different from the rest*. (LA 14)
>
> *The FYP he did recently was very rare and unique*. (LS 20)
>
> *He always has very distinctive solutions whenever I ask the students to solve a problem.* (LE 7)

It was a positive indication that the lecturers did not just appreciate an entire newness, but valued partial degrees of novelty produced by the students. An emphasis on *Innovativeness* may also reflect a positive value for creativity instead of encouraging conformity.

With regards to the Outcome proposition, most lecturers associated students' creativity with their academic output, particularly students' final year project (FYP). Four lecturers related their students' creativity to the *Product* (concrete product) students produce; two lecturers related student creativity to the *Process* (a set of methodologies or procedures) students produce; two lecturers related student creativity to the *Concept* (an abstract idea) students produce. The quote below from an Engineering lecturer shows how he associated student creativity to all the three types of outputs his student produced i.e., *Concept, Process* and *Product*. It shows that the lecturers' understanding of creativity in a student includes the types of outcomes the student produces i.e., *Concept, Process* and *Product*.

> *The other day she presented her FYP. Not only the concept [Concept] of the FYP is innovative, but the methods [Process] she proposed are quite surprising…when she finally showed the end product [Product], it was truly impressive. (LE 9)*

None of the lecturers in this study highlighted students' traits when identifying creative students. Moreover, none of the lecturers' nominations in this study was based on students' academic performance (e.g., smartness, doing well in class). This situation suggested that these lecturers were able to distinguish academic ability from creativity.

6.3.1.2.4 Lecturers' Criteria for Creative Lecturers

Table 6.8 below presents the lecturers' criteria for creative lecturers with reference to the five propositions for creativity. Criteria for identifying creative lecturers were based on the Value, Mental, Outcome and Trait propositions. 72 lecturers (68.57%) did not nomitate a lecturer. Out of the 33 lecturers, 22 of them viewed creativity of their colleagues from a single perspective. 11 of them provided two dimensional definitions. Among the two dimensional definitions, six lecturers described their creative colleagues from the Mental and Value propositions; five lecturers expressed their views from the Outcome and Value propositions.

Table 6.8

Lecturers' Identification of Creative Lecturers

Proposition	**Percentage of codes (no. of codes)**	**Percentage of lecturers (no. of lecturers)**
Value	58.18% (32)	39.40% (13)
Mental	21.82% (12)	27.27% (9)
Context	-	-
Outcome	14.55% (8)	24.24% (8)
Traits	5.45% (3)	9.09% (3)

Note. Total no. of codes=55; total no. of lecturers indicated their views=33

Value was most emphasised by the lecturers (58.18%). Surprisingly, there was an apparent 36.36% difference between the frequency of codes for Value and Mental propositions. These two propositions have been valued almost equally in the earlier analysis. A plausible reason for this big gap may be because their colleagues' teaching impact could be more easily known and therefore more apparent than their thinking processes when designing lesson plans and teaching.

In the Value proposition, the lecturers gauged their colleagues' creativity based on the ability to come up with teaching approaches that are *Innovative*, able to *Enhance understanding* of students, and the ability to make *Professional contribution*. The common criterion lecturers used to identify their creative colleagues was based on the *Innovativeness* of their teaching methods. This view was highlighted by five lecturers. This was similar to how students identified creative lecturers. The quotes below demonstrate this perception:

> *He has a lot of very innovative teaching approaches.* (LA 4)
>
> *His teaching is very unconventional*. (LS 19)
>
> *She teaches using very unique concept of teaching. I can't think of that.* (LE 25)

Besides, concurring with the students' views about creative lecturers, the lecturers (four of them) often related their colleagues' creativity to the ability to enhance student understanding *(Enhancing understanding)*. These views are reflected in the quotes below:

> *She knows how to teach to make students understand*. (LE 7)
>
> He tries every possible way to get students to understand a topic, and he is very good at that. (LS 3)
>
> *She uses a lot of games to help students understand topics.* (LS 21)

Another four lecturers also related lecturers' creativity to *Professional contribution*. *Professional contribution* refers to the lecturer's knowledge contribution to particular fields. Such contribution can be manifested in various forms including publication, conference presentations and interview invitation. These opinions can be seen in the following quotes:

> *He publishes a lot. He contributed a lot to the media field*. (LA 12)
>
> *She is a big name in the engineering field, he is in many conferences and he contributes so much that everyone already knows him.* (LE 23)

He has lots of publications, from books to journals and also always gets invitation to share opinions in TV interviews. (LS 23)

This shows that university academics are expected to teach and actively contribute to knowledge sharing and generation through research.

6.3.1.3 Conclusion on the Reference Population's Definitions of Creativity

When defining creativity as a concept, the impact of a creative outcome (Value) and the mental processes involved in provoking creativity (Mental) emerged as the most prominent aspects of creativity highlighted by the participants. Most of the participants believed that creativity is the ability to produce an innovative and original output, as well as to solve problems. A minority of the participants believed that creativity is something of a personal vale and a result of an "aha" moment (Spontaneous).

When defining creative individuals, to the students, they associated their peers' creativity with the ability to problem solve, the ability to produce innovative ideas and to produce solutions that have a personal value i.e., novel or useful to the creators themselves. The view regarding personal values is more apparent when the students defined their creative peers. Creative lecturers were appreciated by the students for the ability to produce multiple teaching approaches (Divergent thinking), connect content to students' experiences and real-world context (Making connections) and engage with students based on students' interest (Engaging students). Additionally, creative lecturers were seen as those who produce teaching approaches that are unconventional (Innovativeness) and enhance student understanding (Enhancing understanding).

Among the lecturers, creative students were mostly described as ones who exhibit critical thinking (Critical thinking), and, demonstrate ability to combine ideas (Integrating ideas), and the ability to produce innovative ideas (Innovativeness). When describing their colleagues, the lecturers mostly associated creativity with the colleagues' ability to produce and employ innovative approaches (Innovativeness), to teach in a way that enhance student understanding (Enhancing understanding) and to contribute knowledge to the professional domain (Professional contribution).

In general, regardless of whether the participants were describing creativity as a general concept of as an individual's quality, creativity was often related to the thinking process (Mental proposition) and the impact of the creative outcome produced (Value proposition).

6.3.2 Relevance of the Strategies in the Taxonomic Framework

This section presents the findings on (i) the order of strategies ranked by the participants and (ii) their perceptions of the relevance of the strategies.

6.3.2.1 Order of the Strategies

Table 6.9 presents the summed rank, mean rank, and the ranking order of the six strategies i.e., *Replicate, Imitate, Transfer, Characterise, Transform* and *Create* from all students and lecturers. The ranking is from 1 to 6, with 1 being the strategy that was perceived as the least creative, and 6 being the one that was perceived to be the most creative. *Replicate* was perceived to be the least creative strategy (mean rank: S=1.56; L=1.70), followed by *Imitate* (mean rank: S=2.25; L=2.03), *Transfer* (mean rank: S=3.13; L=3.14), *Characterise* (mean rank: S=3.99; L=3.82), *Transform* (mean rank: S=4.34; L=4.54), and *Create* (mean rank: S=5.73; L=5.78). This means that the ranking of strategies, according to the participants' perceived level of creativity in ascending order was *Replicate, Imitate, Transfer, Characterise, Transform* and *Create*. The order of each strategy ranked by both students and lecturers was the same as the order in my taxonomic framework. Table 6.10 displays the number of participants who gave each rank to the six strategies. The similarity suggested that both students and lecturers perceived the lowest reproductive thinking as the least creative strategy and the highest productive thinking as the most creative strategy.

Table 6.9

Ranking of Strategies according to Participants' Perceived Level of Creativity

Strategies	**Summed Rank**		**Mean Rank**		**Ranking**	
	Student, S	**Lecturer, L**	**Student, S**	**Lecturer, L**	**Student, S**	**Lecturer, L**
Replicate	488	180	1.56	1.70	1	1
Imitate	703	217	2.25	2.03	2	2
Transfer	977	329	3.13	3.14	3	3
Characterise	1245	403	3.99	3.82	4	4
Transform	1354	479	4.34	4.54	5	5
Create	1787	607	5.73	5.78	6	6

Note. Total number of students=334; total number of lecturers=105; S=student; L=lecturer

Table 6.10

Ranking of Each Strategy from 1st to 6th Ordered by the Participants

Rank / **Strategies**	**1st**		**2nd**		**3rd**		**4th**		**5th**		**6th**	
	S	**L**	**S**	**L**	**S**	**L**	**S**	**L**	**S**	**L**	**S**	**L**
Replicate	222	72	49	13	15	7	11	6	11	5	4	2
Imitate	59	19	179	71	34	7	20	5	16	3	4	0
Transfer	11	7	49	8	167	62	60	21	23	6	2	1

Characterise	7	4	20	9	60	15	117	49	98	28	10	0
Transform	5	1	10	2	35	11	100	21	142	63	19	7
Create	4	2	4	0	2	2	10	2	19	3	275	96

Note. Total number of students=334; total number of lecturers=105. S=students, L=lecturers

The Friedman test showed a significant difference in the students' ranking of strategies, $\chi^2(5)=1062.622$, $p<.05$. The post-hoc analysis revealed significant differences between all pairs of strategies ($p<.008$), except between *Characterise* and *Transform* ($p=.279$). This suggested that the students perceived *Transfer* and *Characterise* as belonging to a similar level of creativity. Similarly, the Friedman test showed a significant difference in the lecturers' ranking of strategies, $\chi^2(5)=358.359$, $p<.05$. The post-hoc analysis revealed significant differences between all pairs of strategies ($p<.008$), except between *Transfer* and *Characterise* ($p=.125$) and *Characterise* and *Transform* ($p=.18$). This indicated that the lecturers perceived *Characterise* as equally creative as Transfer and *Transform*. Table 6.11 presents the results of the post-hoc analysis for student and lecturers' ranking of the strategies.

Table 6.11

Results of the Post-hoc Analysis for the Student and Lecturers' Ranking of the Strategies

Strategy Pair	**Student**		**Lecturer**	
	Z	***p***	**Z**	***p***
Replicate – Imitate	-.689	.000	-.1.113	.000
Replicate – Transfer	-1.564	.000	-1.438	.000
Replicate – Characterise	2.423	.000	-2.119	.000
Replicate – Create	2.776	.000	-2.838	.000
Replicate – Transform	-4.163	.000	-4.076	.000
Imitate – Transfer	-.875	.000	-1.110	.000
Imitate – Characterise	1.734	.000	-1.790	.000
Imitate – Transform	2.087	.000	-2510	.000
Imitate- Create	-3.474	.000	-3.748	.000
Transfer – Characterise	.859	.000	-.681	.125
Transfer – Transform	1.212	.000	-1.400	.000
Transfer – Create	-2.599	.000	-2.638	.000
Characterise – Transform	.353	.279	-.719	.080
Characterise – Create	-1.740	.000	-1.957	.000
Transform – Create	-1.388	.000	-1.238	.000

Note. Z=Z value; p=Asmp. Sig (2-tailed)

The lack of statistical significance between *Characterise* and *Transfer* as well as *Characterise* and *Transform* suggested that *Characterise* perhaps does not have a clear distinctiveness as a unique strategy. The role of *Characterise* as a strategy needs to be further examined.

6.3.2.2 Participants' Perceptions of the Order of Strategies

To understand the participants' perceptions of the order of strategies proposed in the taxonomic framework, Table 6.12 shows whether the participants who gave a different ranking preferred their own ranking or the arrangement of strategies in the framework. The lecturers were more confident with their own ranking than the students. 42.85% of the lecturers preferred their own ranking while only 18.26% of the students preferred their own ranking. 26.65% of the students and 34.29% lecturers did not indicate their preferences.

Table 6.12

Participants' preference for strategy order

Preference	Percentage of codes (no. of codes)	
	Students	**Lecturers**
The framework's order of strategies	55.09% (184)	22.86% (24)
Their own order of strategies	18.26% (61)	42.85% (45)

Note. Total no. of students=334; total no. of lecturers=105

Unlike the lecturers, most of the students who had a different ranking believed that the order of strategies in the framework was better than theirs after comparison. This could be because of participant bias (Saldaña, 2009), which led them to respond in a way that they think the researcher wanted them to respond. It may also be because they believed that the researcher is more knowledgeable in the subject matter. Students and lecturers who endorsed the order of strategies in the framework thought that the framework's order was more logical.

6.3.2.3 Participants' beliefs about whether the framework reflects the range of strategies associated with creativity

Table 6.13 indicates that the majority of students (S=75.15%) and lecturers (L=67.62%) agreed that the framework captured the array of strategies entailed in any creative endeavour. There were only a few participants (S=5.09%; L=10.48%) who showed disagreement.

Table 6.13

Taxonomic Framework's Reflection of Creative Strategies

Whether the framework reflects the range of strategies related to creativity	Percentage of codes (no. of codes)	
	Students	**Lecturers**

Yes	75.15% (251)	67.62% (71)
No	5.09% (17)	10.48% (11)
Did not indicate	19.76% (66)	21.9% (23)

Note. Total no. of students=334; total no. of lecturers=105

Table 6.14 presents participants' justification for their endorsement and disapproval for the framework's accuracy and comprehensiveness. The participants believed that the strategies are appropriate, and that the framework has covered a range of strategies that reflect creativity because of two main reasons. The first reason was that there is a *Sense of progression* (S=47.60%; L=40%) from one strategy to another; the second was that the framework could *Scaffold the development of creativity* (S=27.54%; L=27.62%). A minority of the participants who contradicted this view largely contested the relevance of certain strategies (S=3.59%; L=10.48%). A small group of students (1.5%) felt that the list of strategies were not comprehensive. Some participants (S=19.77%; L=21.9%) did not indicate their views.

Table 6.14

Participants' Reasons for Their Endorsement and Disapproval for the Accuracy and Comprehensiveness of the Strategies

Reasons (Framework reflects strategies involved in creativity)	**Percentage of codes (no. of codes)**	
	Students	**Lecturers**
Sense of progression	47.60% (159)	40% (42)
Scaffolds for creativity	27.54% (92)	27.62% (29)
Reasons (Framework does not reflect strategies involved in creativity)	**Percentage of codes (no. of codes)**	
	Students	**Lecturers**
Irrelevance of some strategies	3.59% (12)	10.48% (11)
Non-comprehensiveness	1.5% (5)	-

Note. Total no. of students=334; total no. of lecturers=105

Sense of progression refers to the sequential organisation of the creative strategies based on the (i) level of creativity and (ii) the level of complexity involved in the mental processes. Both students and lecturers reckoned that the overall developmental structure embedded in the framework exemplifies and covers the different levels of innovation and mental complexity that are required for achieving creativity. The quotes below illustrate this point:

> *The strategies are arranged in a way that is from the simplest to more complex integration of knowledge….it covers all the skills from lowest to highest levels that necessitate creativity.* (LE 34)

> *The strategies are arranged from least to most creative. It shows how creativity could progress.* (SA 38)

Scaffolds for creativity refers to the support provided towards attaining creative competence. Using their own experience in being creative, they viewed the framework as a reflection of past experiences, especially in the stages that they experienced in learning to be creative. The order of the strategies was seen to be able to scaffold learning of creativity. This can be portrayed in the quotes from a student and a lecturer below:

> *This is how exactly what I usually do when I try to be creative…I remember when having a project in University A, these are what I used, but I just didn't realise it. So I think it can represent something like real life experience.* (SS 4)

> *The strategies reflect real life experience. They can guide people to be creative*. (SA 8)

> *The sequence is very logical. I think I went through the same process. The 6 strategies can be a skeleton to guide people to be creative*. (LS 14)

Participants who did not agree with the strategies in the framework felt that some of the strategies, particularly *Replicate* and *Imitate,* were irrelevant to the concept of creativity. Their awareness of reproductive and productive thinking (as shown in the way they defined creativity) did not seem to lead them to see *Replicate* and *Imitate* as strategies to be creative. Most of the participants in this group approved only *Transform* and *Create*, a finding that parallels their definition of creativity was producing innovative and original outputs.

6.3.2.4 Proposed Modifications to the Strategy Order

Table 6.15 demonstrates the participants' general view on whether the framework should be amended. A small number of participants (S= 3.98%; L=3.81%) did not indicate their views. A few students (S=5.09%) were uncertain of their views. There is an inconsistency in how the students and lecturers believed about the strategy order in the framework. While the students (65.27%) largely agreed with the current order of strategies, the lecturers (62.86%) predominantly believed that the strategy order needs to be modified.

Table 6.15

Whether changes need to be made to the framework

Whether changes are necessary	**Percentage of codes (no. of codes)**	
	Students	**Lecturers**
Yes	25.75% (86)	62.86% (66)
No	65.27% (218)	33.33% (35)
Maybe	5.09% (17)	-
Did not indicate	3.98% (13)	3.81% (4)

Note. Total no. of students=334; total no. of lecturers=105

The proposals for modification offered by the participants are shown on Table 6.16. The most common suggestions were *Reordering* (S=9.58%; L=20.95%) and *Combining* strategies (S=5.98%; L=17.14%), followed by *Removing* (S=3.29%; L=14.29%) and *Adding* strategies (s=1.50%; l=1.90%).

Table 6.16

Participants' Proposals for Modifications

Modifications	**Percentage of codes (no. of codes)**	
	Students	**Lecturers**
Reordering	9.58% (32)	20.95% (22)
Combination	5.98% (20)	17.14% (18)
Removal	3.29% (11)	14.29% (15)
Addition	1.50% (5)	1.90% (2)

Note. Total no. of students=334; total no. of lecturers=105

The participants suggested to swap between *Transfer* and *Transform* as the latter was seen to require more complicated skills. The participants interpreted that *"transforming requires the skill of combining features from different solutions, however transfer is just to borrow ideas from unrelated fields,"* (SS 45). There were also suggestions to shift *Characterise* to the most basic level of creativity because "*analysing a problem should be the most basic strategy before applying other strategies*" (LA 24). Additionally, strategies that were deemed similar were proposed to be combined as one. These strategies are *Replicate* and *Imitate*, *Transfer* and *Characterise*, as well as *Transform* and *Create*. Due to the perceived similarities between *Replicate* and *Imitate* as well as *Transfer* and *Transform*, there also suggestions to remove *Replicate* and *Transfer* from the taxonomic framework. There were no suggestions on how other strategies can be added to the framework.

Parallel to the results shown in the post-hoc test that *Characterise* has been seen as similar to *Transfer* and *Transform*, there were several recurring concerns regarding *Characterise* as a strategy. *Characterise* in this framework was defined as an analysing tool to break down the problem or situation to develop a solution. Although I initially perceived

Characterise as more creative than *Transfer* and less creative than *Transform*, the participants viewed it as a prerequisite to all other strategies.

> *Based on the experience as a multitude designer, I would say to characterise a product/prototype might be a rather easy task because it is basically the understanding of the characteristics of the product/prototype, then followed by imitating and replicating a product.* (LA 15)

> *I think characterise could be considered a feature that can be used within each factor more than being a factor on its own.* (LS 20)

> *Characterise is one of the predominant precursors among all the proposed six creative strategies, as characterise involves analysis or interpretation of a problem which requires preliminary conceptual brainstorming or critical thinking in order to proceed to transformation realisation and creation of an object.* (SE 109)

The recurrent issues with *Characterise* warrant further investigations about its relevance as a strategy in the taxonomic framework.

6.3.3 Relevance of the Taxonomic Framework to the Reference Population

This section examines the participants' perceptions of the relevance of the taxonomic framework.

6.3.3.1 Potential of the Taxonomic Framework for Facilitating Understanding and Developing Creativity

Table 6.17 presents the participants' beliefs about whether the framework was useful for understanding and developing creativity. A small number of students (12.28%) did not indicate their perceptions towards the framework's potential in these two areas. This question has a limitation as it contained two questions i.e., facilitating understanding and developing creativity, simultaneously. However I was still able to derive codes from the participants' responses to differentiate their views towards the framework's potential in facilitating understanding creativity and developing creativity. All the participants distinguished between the two in their responses; their responses for both were identical. Therefore I counted them as one response for both aspects. The participants were predominantly confident that the taxonomic framework would be useful for understanding and nurturing creativity (S=72.46%; L=72.38%).

Table 6.17

Participants' beliefs about the usefulness of the taxonomic framework in understanding and developing creativity

Whether the framework can assist in understanding and developing creativity	**Percentage of codes (no. of codes)**	
	Students	**Lecturers**
Yes	72.46% (242)	72.38% (76)
No	15.27% (51)	27.62% (29)
Did not indicate	12.27% (41)	-

Note. Total no. of students=334; total no. of lecturers=105

This finding gave a positive outlook on how the framework may function in actual practice. Justifications given by the participants, as shown in Table 6.18, were that the strategies provided the users with a sense of progression from one strategy to another (S=59.29%; L=49.52%). However, some participants did not believe that the framework was useful in facilitating understanding and developing creativity because they perceived that the framework was unnecessary (S=11.38%: L=8.57%), restricts creativity (S=3.89%; 13.33%) and was too theoretical (L=5.71%). A few participants (S=25.44%; L=22.87%) did not share their views on this.

Table 6.18

Participants' Perception of the Taxonomic Framework's Usefulness for Understanding and Developing Creativity

Reasons (useful)	**Percentage of codes (no. of codes)**	
	Students	**Lecturers**
Sense of progression	59.29% (198)	49.52% (52)
Reasons (not useful)	**Percentage of codes (no. of codes)**	
	Students	**Lecturers**
Not necessary	11.38% (38)	8.57% (9)
Framework restricts creativity	3.89% (13)	13.33% (14)
Too theoretical	-	5.71% (6)

Note. Total no. of students=334; total no. of lecturers=105

The *Sense of progression* refers to the sequential organisation of the creative strategies based on the level of creativity involved in the mental processes. The sense of progression was believed to be able to facilitate in understanding the different levels and types of creativity, as well as assessing and developing creativity. The quotes below from a student and two lecturers are examples that instantiate this justification:

> *Because there is a progression from low to high creativity, it is useful to help me understand and realise that there are these different levels of creativity out there.* (SE 6)

> *I like the progression of the level of complexity there. It shows the different types of creativity.* (LA 31)

> *I think I can assess my students' creativity and help them develop their creativity gradually using the degree of creativity presented in the framework.* (LS 13)

Students who were pessimistic about the framework's usefulness for understanding and developing creativity, largely felt that a creativity framework is unnecessary, because to them, creativity occurs only from the aha-moments:

> *Creativity comes by itself without a need for a guideline. Sure it may be good to know the processes but ultimately I believe it stems from one's mind.* (SE 105)

> *I think creativity is all spontaneous. You can't use a framework to make it happen.* (SA 78)

A small number of participants felt that having a framework to develop creativity was indirectly restricting creativity, as reflected in the quotes below:

> *It is kind of restricting as the framework indirectly suggests adherence to the strategies* (LE 60).

> *The framework would make people unconsciously follow the strategies, in a way it stops creativity instead of promoting it.* (SS 1)

A few lecturers (5.71%) commented that the framework was conceptual and theoretical, and therefore was difficult to be translated into something practical to support creativity development. Two quotes were presented to illustrate this view:

> *(The framework is) not useful because all these are merely concepts – it is hard to segregate/put a boundary between concepts. So it is really not easy to make it doable in reality, as in to develop creativity*. (LS 23)

> *It is difficult to tell if it really functions, because it is rather theoretical at the moment.* (LA 5)

This may imply that they disparaged the view that creativity is a teachable and learnable skill. In spite of these views, the participants generally indicated that the framework could help clarify the "*subjective*" (SS 81), "*implicit*" (SA 6), "*contextually or culturally situated*"

(LA 27), "*ambiguous*" (LE 13), "*little understood trait*" (LA 2) and "*endless*" (LS 15) characteristics of the concept of creativity.

6.3.3.2 Comprehensibility of the Taxonomic Framework

Table 6.19 shows the participants' assessment of the framework's comprehensibility. both students (76.35%) and lecturers (75.24%) largely believed that the framework is easy to understand. The positive findings implied that the framework may potentially be easily accepted and used by both students and lecturers in reality.

Table 6.19

Participants' beliefs about the comprehensibility of the taxonomic framework

Whether the framework is comprehensibility	**Percentage of codes (no. of codes)**	
	Students	**Lecturers**
Yes	76.35% (255)	75.24% (79)
No	23.65% (79)	24.76% (26)

Note. Total no. of students=334; total no. of lecturers=105

Table 6.20 below lays out the reasons provided by the participants regarding the framework's comprehensibility. The *Comprehensiveness* of the framework was seen by the students as a main strength that could facilitate their understanding of creativity (S=32.94%). *Clear language* (S=28.44%; L=55.24%) and *Content presentation* (S=14.97%; L=20%) were other factors that contributed to the comprehensibility of the framework. However, some students (23.65%) and lecturers (24.76%) felt that the long sentences used in the framework have impeded understanding.

Table 6.20

Participants' Beliefs about the Comprehensibility of the Framework

Reasons (easy to understand)	**Percentage of codes (no. of codes)**	
	Students	**Lecturers**
Comprehensiveness	32.94% (110)	-
Clear language	28.44% (95)	55.24% (58)
Content presentation	14.97% (50)	20.00% (21)
Reasons (not easy to understand)	**Percentage of codes (no. of codes)**	
	Students	**Lecturers**
Long sentences	23.65% (79)	24.76% (26)

Note. Total no. of students=334; total no. of lecturers=105

The *Comprehensiveness* of the framework refers to the different details on the framework (e.g., examples, definitions, impact presentd in Figure 5.5) that help clarify the process involved in being creative. They demonstrated understanding that Strategies or their creative actions (Mental) are related to consequences (Outcome) and impact (Value).

> *The other details like 'impact' and 'outcome' describe each strategy well. The examples really help me to understand the strategy!* (SS 57)
>
> *I see that the strategies have 'impact' and 'outcome' so I see it as every strategy got something that comes out of it…and the examples and definitions make the strategy clear.* (SA 34)
>
> *So I assume if we use those strategies, we produce something creative. I really like the examples and definitions and the layout. It makes it quite clear.* (SE 6)

The participants also believed that the language used in the framework was clear without overly complex words (*Clear language*), and therefore easy to understand.

> *The language is clear and not difficult.* (SA 78)
>
> *The words are not difficult and it's easy to understand.* (SS 98)
>
> *The language is clear and it does not pose any confusion to me, and I think even students in general can understand that.* (LS 8)
>
> *It's quite easy to understand because it does not have any technical terms*. (LA 37)

The participants felt that the *Content presentation* is clear and engaging. They also appreciated the images used to illustrate each strategy, and the graphic organiser used in explaining and expressing concepts for each strategy. The quotes below illustrate this position.

> *The way in which the content is presented is engaging and it speaks to the readers.* (SA 89)
>
> *The layout is clear and is not cluttered. It is easy to follow*. (SS 9)
>
> *The images made it quite engaging and somewhat easy to visualise the strategy.* (LE 81)
>
> *The graphics used made it easier to understand the strategies, instead of just words.* (LS 45)

Participants who found the framework not comprehensible pointed out that some of the sentences were too long. Consequently, they suggested using shorter sentences, visual images and other examples to explain the strategies.

6.3.3.3 User friendliness of the Taxonomic Framework

Table 6.21 below presents the participants' evaluation on the user-friendliness of the framework. Some of the participants (S=24.55%; L=22.86%) did not express their views. The participants' assessment was inclined to the positive side (S=64.07; L=68.57), although some of them (S=11.38; L=8.57) were unsure whether it was user friendly. This could be because they were not able to comment on this aspect as they had yet to use the framework in practice.

Table 6.21

Participants' beliefs about user-friendliness of the taxonomic framework

Whether the framework is user friendly	**Percentage of codes (no. of codes)**	
	Students	**Lecturers**
Yes	64.07% (214)	68.57% (72)
No	11.38% (38)	8.57% (9)
Maybe	24.55% (82)	22.86% (24)

Note. Total no. of students=334; total no. of lecturers=105

As shown in Table 6.22, *Language* is the main aspect that contributed to the framework's user-friendliness (S=28.74%; L=36.19%). Content Presentation was also another factor contributing to the user-friendliness of the framework (S=19.16%; L=10.48%). While the lecturers did not acknowledge the framework's comprehensive details as a feature that makes the framework easy to understand, they believed that these details *(Comprehensiveness)* would support them in using the framework (S=16.17%; 21.90%). However, some of them highlighted that the absence of guidelines (S=7.79%; L=16.19%) and the long sentences (S=3.59%; L=6.67%) used in the framework impeded its user-friendliness. A few of them (S=24.55%; L=8.57%) did not share their opinions.

Table 6.22

Participants' Beliefs about the User-friendliness of the Framework

Reasons (user-friendly)	**Percentage of codes (no. of codes)**	
	Students	**Lecturers**
Language	28.74% (96)	36.19% (38)
Content presentation	19.16% (64)	10.48% (11)
Comprehensiveness	16.17% (54)	21.90% (23)
Reasons (not user-friendly)	**Percentage of codes (no. of codes)**	
	Students	**Lecturers**
Absence of guidelines	7.79% (26)	16.19% (17)
Long sentences	3.59% (12)	6.67% (7)

Note. Total no. of students=334; total no. of lecturers=105

The main reason *Language* made the framework user-friendly was because of the straightforward language and simple words used in the framework. This view is illustrated in the following quotes:

> *The language is straightforward. There's nothing that I don't understand*. (SS 8)
>
> *The language is simple and not much technical words. (*SE 79)
>
> *The words in the framework are pretty simple and easy to understand. This way it doesn't require effort to use it*. (LA 20)
>
> *It's easy to use because the language is clear and there seems to be no jargons although the examples are medical related*. (LS 29)

Comprehensiveness refers to the thorough details covered in the framework. These details included the definitions of strategies and the examples provided to illustrate the strategies.

> *The framework covers very sufficient details that I think could help navigate us when we use it. (LA 4)*
>
> *The details are comprehensive. These details will come in handy when we use it I believe. (LS 23)*
>
> *I think it will be easy to use because there is different information (examples, impacts, definitions) to explain the strategies. (SS 68)*
>
> *The details support me to use the framework because they help me understand it better. The examples are particularly useful.* (SA 89)

The *Absence of guidelines for implementation* was the major barrier for the participants to believe that the framework is user-friendly. They explained that they did not know and were not sure of how the framework can be used. The quotes below reflect this viewpoint:

> *Maybe provide some sort of insight on how to implement it.* (SS 9)
>
> *I think everything is clear, but the usage part lacks clarity.* (LE 18)
>
> *Would be good if each strategy had one clear, simple sentence explaining it as a quick reference guide for implementation.* (LS 38)

Concurring with the way in which some participants felt about the long sentences used in the framework has impeded comprehensibility, the *Long sentences* were also seen by a few participants as a factor that has caused the framework less user-friendly.

The sentences are too long, I need to read twice to understand it, so quite difficult to want to use it. (SA 28)

Too long sentences. Not easy to read, maybe a bit hard when using it. (SS 75)

The sentences maybe too long for the students, although the language is quite simple. Some students may take some time to read it. I don't think it's user-friendly. (LE 43)

The participants suggested using simpler language and short sentences, more visual images and include examples from different disciplines to explain each strategy, the same proposals for improving the framework's comprehensibility. They also suggested incorporating a user-guide for implementation to assist users in using the framework.

6.3.3.4 Uses of the taxonomic framework

Table 6.23 displays the participants' ideas on the possible uses of the taxonomic framework. It informed the participants' views on the feasibility and practicality of the framework. The framework was generally suggested for *Teaching*, *Learning* and *Assessment*. Uses in relation to *Teaching* were suggested primarily by the lecturers; uses in relation to *Learning* are mainly proposed by the students; uses with regard to *Assessment* were evenly suggested by both students and lecturers.

Table 6.23

Suggested Uses for the Taxonomic Framework

Uses	**Percentage of codes (no. of codes)**	
	Students	**Lecturers**
Teaching	21.26% (71)	42.86% (45)
Learning	35.33% (118)	20% (21)
Assessment	37.72% (126)	26.67% (28)
Will not use	5.69% (19)	10.48% (11)

Note. Total no. of students=334; total no. of lecturers=105

In *Teaching*, the taxonomic framework was perceived to be useful for several purposes i.e., *Incorporating strategies into curricula, or problem solving* and *Raising awareness about creativity*. *Incorporating strategies into curricula* refers to integrating the strategies in the planning of creative lessons for projects, designing materials and designing modules for developing or training creativity and problem solving.

I will compare my current creativity strategy in teaching using this framework. I will apply the appropriate level of creativity when dealing with students from different

> *academic year, as the learning approach of students varies from each year. Year 1 students tend to learn via replication or imitation. I have higher expectation on year 3-4 students, as they are required to have higher level of creativity in completing their research or projects. When year 3-4 students do not show transfer or characterisation skill, I will probably alter my teaching method to help them to achieve higher level of creativity. Therefore, this framework is handy for improving my teaching.* (LE 1)

> *If I have a company in future, I will use it to for training, particularly in training for creativity, critical thinking and problem solving.* (SA 15)

> *I could bring it to my field to show the students the different possibilities that exist when faced with a problem.* (LE 26)

Raising awareness about creativity refers to informing individuals about creativity with the intention of raising understanding of creativity and influencing their attitudes towards the achievement of being creative. It also denotes to acting as a metalanguage for creativity among educators. This position is reflected in the quotes below:

> *It can be used to get people to understand what is being creative and how to reach it.* (SA 76)

> *It maybe quite useful for people to understand creativity better, and maybe can correct their beliefs.* (SE 93)

> *I think it can raise awareness about creativity to change students' attitudes about creativity.* (LS 5)

> *It can help raise awareness among educators about what creativity is, because the current definition is quite messy. To help educators to have the same understanding of creativity, this framework can be used as a metalanguage for creativity among educators.* (LA 79)

In *Learning,* the framework could be used as a *Guide for developing ideas* for brainstorming purposes in student's assignment and lecturers' teaching. This view is reflected in the quotes below:

> *I would use this framework for our chemical product design module to find solutions or create a new product.* (SE 57)

> *I would use it (the framework) to brainstorm ideas for my clubs.* (SA 6)

> *I think I would use this (the framework) for my teaching breakthrough. I think I can learn some creative ideas to help with my teaching.* (LE 9)

The main point emphasised by the students was that the framework would particularly be useful when they are struggling in a problem solving or idea development process for daily and academic matters. The quote below demonstrates these positions:

This framework is not for us to use it whenever we solve a problem, but for us to refer to when we are stuck. (SS 68)

The framework can be used to stimulate some braincells, especially when I can't think of any ideas, especially for the "Soil" module. (SE 74)

I think when I can use it when there is a bottleneck. (LA 26)

In *Assessment*, the taxonomic framework was perceived to be helpful for *Assessing creativity* and *Self-assessment*. *Assessing creativity,* mainly expressed by the lecturers, refers to using the framework as a guide to assess individual creativity. The lecturers would use it to gauge students' creativity and the students would use it to assess their peers' creativity.

I will use it to assess my students' work such as research, projects and assignments. (LS 6)

I can use it to assess my students' creativity, especially their FYP. I can decide their level of creativity basing it on this framework. (LE 27)

I think I'll use it with students. I can tell them that they will be graded based on this [the framework]. For students also it helps them to figure out if they are ready for certain strategies. (LA 18)

I will be able to know what others, like my friends' creativity. I will know where they stand in terms of their creativity, whether they are in the lower or higher side of creativity. (SA 79)

Self-assessment denotes evaluating one's own creativity. The participants expressed they could use the framework to assess their flow of thinking, and to assess their own ideas during the process of problem solving and idea generation for their projects, day-to-day problem solving, research and hobbies. The quotes below show how the framework can be used for assessment by students and lecturers:

I would use this framework to assess my flow of thinking and my final year project. (SE 110)

I can use it for my own daily work and problem solving, to see which level my ideas are at. (SS 4)

I can assess my own creativity in my research work, to see if my research meets which criteria for creativity. (LS 44)

It would be rather useful to evaluate how creativity in baking. (LE 61)

6.3.3.5 Areas of Concern about the Taxonomic Framework

The concerns about the framework expressed by the participants are tabulated in Table 6.24. In total, there were only a relatively small number of the participants (S=23.35%; L=31.43%) who raised concerns about the framework. Two major concerns that were constantly raised were *Rigidity* imposed by the framework and the perceived *Spontaneous nature* of creativity. A few participants were concerned about the unequal importance assigned to each strategy (*Strategy Value*). In spite of the positive outlook, these concerns needed to be taken into account to enhance the framework's feasibility and value.

Table 6.24

Participants' Concerns about the Taxonomic Framework and Its Functions

Concerns	Percentage of codes (no. of codes)	
	Students	**Lecturers**
Rigidity	10.18% (34)	15.72% (17)
Spontaneous nature	7.48% (25)	10.80% (11)
Strategy value	5.69% (19)	4.91% (5)

Note. Total no. of students=334; total no. of lecturers=105

Firstly, *Rigidity* refers to the participants' perception that the framework imposed a series of prescriptive steps in creativity. They assumed that the framework attempted to organise and condition the development of the creative process prescriptively. This concern is shown in the quotes below:

> *I think the step-by-step process won't work. We should be able to go back and forth of the strategies.* (SA 79)
>
> *The framework to me is a bit rigid, because it imposes us to do it from step 1 to 6.* (SE 91)
>
> *It seems to be like a rigid framework to me – the step-by-step way, everyone may have a different start.* (LE 14)

Spontaneous nature refers to the participants' perception that creativity is impromptu in that it tends to happen at the spur of the moment. The framework therefore was perceived to have the tendency to force users to follow the strategies, which in turn restricted creative thinking. This view was aligned to the belief that creativity is inspired from the 'aha' moment, which was a common perception in the literature (Mullet et al., 2016). Some quotes are provided below to portray this perception:

> *You can't control creativity because it just comes like that. I think the framework will restrict it.* (SA 6)

> *Creativity is a spontaneous thing. The framework probably forces it to happen but it won't.* (SS 40)

> *Most of the time creativity is natural and spontaneous. Would the framework be too restricting when people are forced to use those strategies?* (LA 7)

Participants' who believed that creativity cannot be predicted or consciously created did not agree that creativity could occur with the guided of a structured framework.

A small number of participants felt that the framework assigned each strategy a particular level of significance (*Strategy Value*), i.e., *Replicate* has the lowest level of importance and *Create* has the highest level of importance. Consequently, some strategies were seen as irrelevant to the concept of creativity. The lecturers were also concerned that the students would deem the higher-level strategies (e.g., *Transform* and *Create*) as more important strategies. This concern about the relevance of strategies is shown in the examples below:

> *Only the two top strategies i.e., 'transform' and 'create' reflect creativity*. (SE 6)

> *I don't think Replicate and Imitate are considered creative.* (SS 49)

> *The students may assume that the higher strategies are better than the lower strategies like Replicate and Imitate.* (LS 5)

This circumstance reflected their preconceived notion about creativity and creative strategies. It appeared that the participants' belief about creativity largely subscribed to producing breakthrough ideas such as *Transform* and *Create*.

6.4 Discussion

This section presents the discussion related to the research question this chapter attempts to address i.e., *what are the perceptions of the reference population on creativity and the relevance of the taxonomic framework?* Stemming from the findings of this study, the discussion in this section will be organised into the areas of investigation in this survey: (i) definitions of creativity, (ii) relevance of the strategies and (iii) relevance of the taxonomic framework.

6.4.1 Definitions of creativity

Findings from the survey revealed that the reference population largely conceptualised creativity as a mental process and an outcome that has the value of innovativeness and originality. Creativity was perceived as a problem-solving process and ideas or solutions that are unconventional and have not existed before. The problem-solving position held by the participants was aligned to previous findings where creativity was seen as utilising multiple searches for solutions to a problem (e.g., Petocz et al., 2009; Vedenpaa & Lonka, 2014). A possible reason to explain this stance would be that real world challenges increasingly require creative solutions (Tan, 2009). The need for dealing with real-world problems may have prompted the link between creativity and problem solving. Additionally, the participants' association of creativity with Innovativeness and Originality concurred with previous findings (e.g., Jahnke et al., 2015; Tsai & Cox, 2012). While past studies have also shown that a creative output needs to be both novel and useful (Boden, 2004; Kilgour, 2007), usefulness was not prominently associated with creativity in this study. The lack of emphasis of usefulness was in consistent with past findings (Hong & Kang, 2010; Stone, 2015; Zhou et al., 2013). The similarities shown between students and lecturers in their emphasis on the Value and Mental propositions suggest that these aspects of creativity are more prominent than the other when it comes to understanding creativity among the higher education students and lecturers.

Findings showed that the understanding of creativity was specific to the context and person. In the context of teaching and learning, students viewed their peers' ability to solve problems and their ability to come up with unconventional ideas as being creative. Students associated their lecturers' creativity with the ability to use diverse and unconventional teaching approaches, connect learning content to students' experiences and reality, engage students and enhance students' understanding as important creative qualities. Concurring with past studies (Cremin et al., 2015; Craft et al., 2013), students attributed their lecturers' creativity to their ability to make connections between learning content and students' experiences and real-world contexts. Among the lecturers, student creativity was associated with critical thinking and the ability to produce unconventional ideas. The appreciation for students' critical thinking concurred with previous studies (e.g., Konstantinidou et al., 2013). This result may be justified by the fact that critical thinking has been identified as a primary skill in higher education (Arend, 2009; Jackson, 2006). Additionally, critical thinking and creative thinking are two skills that function symbiotically. However, this finding must be interpreted with caution because if the lecturers viewed critical thinking as analogous to creativity, this would mean that the opportunities for cultivating creativity in education would be oppressed. In addition, the lecturers believed that creativity in lecturers is demonstrated through their ability to employ unconventional teaching approaches, enhance students' understanding of learning content and contribute knowledge to their professional domain. The association of lecturers' creativity with their ability to strengthen student understanding echoed Craft et al.'s (2014) study.

When relating creativity specifically to a person, students highlighted personal creativity i.e., producing a creative outcome that has a personal value to the creators themselves. In this study, students showed appreciation towards their peers' ability to come up with ways that support their own learning. Personal creativity has been consistently emphasised by creativity scholars (e.g., Boden, 2004; Kaufman & Beghetto, 2009) to recognise developmental creativity. However in creativity research that examines implicit theories of creativity, this view has not been very prominent in previous studies and seemed to appear to be limited to only one study (e.g., Kleiman, 2009). Although this view has not been foremost in this study and previous findings, it is important and needs to be appreciated for its importance in recognising and nurturing individuals' developmental creativity (e.g., Boden, 2004; Kaufman & Beghetto, 2009). The lack of popularity in this stance could be understood in two ways – one could be that personal creativity has not received sufficient attention in education; another could be because of the nature of the survey, which did not allow more time for them to reflect and express other standpoints of creativity.

As a whole, the participants' understanding of creativity reflected the five propositions that underpinned the taxonomic framework i.e., Mental, Trait, Context, Outcome and Value, with a high inclination towards the Mental and Value propositions. In fact, the participants were aware of the mental processes that were involved in creativity i.e., reproductive and productive thinking; however their understanding of these mental processes was general. For example, they acknowledged modification of ideas as a form of creativity, nevertheless they were unaware of the strategies for modifying ideas or solutions. Additionally, they were aware of the importance of innovativeness and originality in creativity; however they did not demonstrate the awareness that the value of creativity can be appraised through a continuum from personal creativity to historical creativity. In this study, the taxonomic framework gave equal importance to all five propositions as each proposition has specific roles in creativity. These roles included the creative strategies, supporting factors for the exercise of creative strategies, the outcomes of creativity and the values of creative outcomes. While the taxonomic framework proposed an inter-relationship among all the five propositions, the participants largely focused on the mental and value propositions, without being aware of the relationship among these different aspects of creativity. As creativity is a teachable and learnable skill (e.g., Dumas et al., 2016; Kamis et al., 2020), without knowing the supporting factors for creativity, and how creative outcomes could manifest, teaching and nurturing creativity will be a hit and miss endeavour.

6.4.2 Relevance of the Strategies

Overall, the order and relevance of the strategies were well received. The participants appreciated the developmental organisation of the strategies (*sense of progression*). However, there were a few concerns about the relevance of the strategies including the appropriateness regarding Characterise as a strategy, the perceived rigidity in the use of the strategy, the perceived spontaneous nature of creativity and the perceived unequal importance assigned to each strategy.

The order of strategies ranked by the participants were identical to that of the taxonomic framework, suggesting that the participants agreed that *Replicate* was the least creative strategy, followed by *Imitate, Transfer, Transform* and *Create* as the most creative strategy. These strategies arranged in a continuum were valued as they gave the participants a sense of how creativity could progress (*sense of progression*). In the teaching and learning context, this developmental structure could facilitate educators and students to identify, recognise and understand various types of creative actions. The continuum bridged the least and the most creative strategies i.e., between *Replication* and *Create*. Therefore, each strategy could act as a scaffold to support the learning and development of creative thinking. Such findings suggested that the strategies in the taxonomic framework could serve as a foundation for teaching and learning of creativity.

Of all strategies, the participants did not agree with the role and order of *Characterise,* which was defined in the taxonomic framework as developing an improved solution through the characterisation of a problem. This finding was shown in the participants' ranking of strategies and their rationalisation. The way in which *Characterise* was defined in the framework was analogous to a concept called *problem identification* or *problem finding* identified in established creative problem-solving models (e.g., Osborn, 1953; Wallas, 1926; Isaksen & Treffinger, 2004). This concept refers to the process of identifying problems to be solved, describing the characteristics of the problem, setting goals to be achieved, gathering necessary facts for solving the problem, as well as examining inhibiting and supporting factors for achieving the goals. Additionally, this has been shown to be particularly important when addressing ill-defined and novel problems (Schraw et al., 1995). As such, *Characterise* was perceived to be a precursor to all other strategies instead of a distinctive strategy.

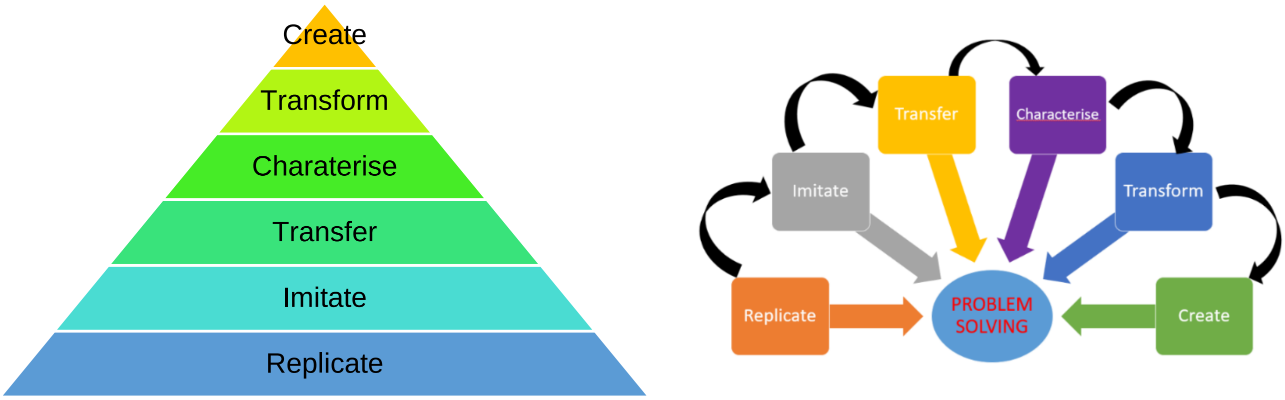
When identifying the features of creativity through a synthesis of literature to develop a taxonomic framework, this strategy was constructed based on the concept of forward incrementation (Sternberg, 1999), the type of creative contribution that moves the field forward from where it currently is. I interpreted this by inferring that such contributions involve and require a reanalysis of the problem to develop an improved solution. Upon reflection on the participants' opinions, I discerned that problem analysis should be an ongoing process throughout the problem-solving activity. It should be mandatory to occur from the onset of the problem-solving process (Osborn, 1953); it is also crucial at any point of the problem-solving endeavour to constantly examine and evaluate not just the problem, but also strategies and solutions to be selected for addressing the problem.

There were a few concerns around the relevance of these strategies. First, the strategies organised in a continuum led participants to perceive that the framework prescribed a rigid model where these strategies were supposed to be exercised in a step-by-step manner, from *Replicate* through to *Create*. While this was not the intention of the strategies to be laid out in a continuum, I attributed this misunderstanding to the pyramid model that was used as visual representation of the strategies. Second, creativity was perceived as a spontaneous act, which would be suppressed with the presence of a taxonomic framework. The notion of creativity as solely an inspiration of the "aha" moment rendered the participants to doubt the use of the framework in cultivating creativity. While this suggested a lack of understanding in the concept of creativity, it may also imply that creativity has not gained an important recognition in higher education. If it was seen as a spontaneous act, it may mean that creativity would neither be explicitly taught nor nurtured. Another concern was related to the lower-level strategies i.e., *Replicate* and *Imitate*. These strategies were deemed to be irrelevant to creativity because they were seen not to be related to creative thinking. Surprisingly, when they defined creativity as a concept, they associated creativity with modifying existing solutions, which closely mirrored the *Imitate* strategy. A way to interpret this finding could be that the connotations of the terms "Replicate" and "Imitate" did not suggest a notion of creativity.

In response to the concerns raised by the participants, though from a minority of the participants, I made modifications to the visual design of the framework. Instead of using a pyramid design that may be perceived to be a model that implied specific degrees of significance assigned to a specific strategy and a prescribed step-by-step model, I used a semi-circular design as shown in Figure 6.1 below. The use of this design allowed me to indicate visually and explicitly that each strategy is significant and may be used as a problem-solving method.

Figure 6.1

Initial and Revised Visual Design of the Taxonomic Framework



Note. The pyramid was the initial visual representation. The revised version is represented in a semi-circular design.

The new design was meant to indicate that when a less complex strategy does not provide a solution to the problem, the problem solver may try the next more complex strategy. Other than the visual representation of the framework's design, the conceptual features of the framework remained unchanged. I kept "*Characterise*" in the framework for further investigation in the next phase.

6.4.3 Relevance of the Taxonomic Framework

The relevance of the taxonomic framework was perceived positively by the majority of the participants for its comprehensibility, user-friendliness and its potential in facilitating understanding and developing creativity. The positive results were attributed to a few reasons including the developmental structure of the framework (sense of progression), comprehensive details about the framework, language clarity, and content presentation. Among these reasons, the developmental organisation of the strategies (sense of progression) was the most important factor contributing to the positive acceptance towards the framework. This could be because such an incremental structure provided a suggested sequence on designing and coordinating curricula, modules and activities. This means that this structure could act as a scaffold for learning creativity. Scaffolding has been recognised as fundamental to foreground relevant knowledge and skills in a staged manner when necessary (e.g., Gajda et al., 2017; Gardiner, 2017). This means that in the context of teaching and learning creativity, students could first be taught the reproductive thinking and then gradually support them to proceed to exercising higher level of productive thinking.

In terms of the potential uses of the taxonomic framework, the framework was regarded useful for teaching, learning and assessment. It could be used for teaching by incorporating the strategies into curricula and raising awareness about creativity. For learning, the framework could be used as guide for developing ideas for teaching and learning. For assessment, it could be employed for assessment of creativity of others and for self-assessment. This finding suggests that the framework could be used for teaching about, teaching for and teaching with creativity. More importantly, the framework's potential use as a self-assessment tool reflected the metacognitive view of the taxonomic framework. Self-assessment involves a reflective process where individuals use criteria to assess their performance and determine how to improve (Silvia & Philip, 2004). It helps develop metacognition and self-regulated individuals (Ibabe & Jauregizar, 2010; Silvia & Philip, 2004). As metacognition is a process that enhances creative endeavours (e.g., Erbas & Bas, 2015; Lizarraga & Baquedano, 2013), the framework as a self-assessment tool may help users identify problems, select strategies for solving the problems, and recognise their own competence and limitations in exercising any strategies. This way the users would be able to self-determine and self-regulate the use of appropriate strategies based on contexts and needs. Drawing from these findings, the framework should function as an assessment *for* learning instead of an assessment *of* learning, to help individuals constantly improve their learning of creativity. Although assessment for creativity was not the scope for this study, this is an important point to be noted for further development of the framework in future. Generally, the fact that the participants viewed the potential of the framework for teaching, learning and assessing creativity had indicated their beliefs that creativity is a teachable and learnable skill.

In the survey, the participants' responses did not highlight the checklist. This could mainly be because they were unclear of how the framework could be used, as highlighted by some of the participants. This means that although the framework was well perceived, without a clear implementation guide, the participants would not be able to connect to the framework according to their teaching contexts.

6.5 Conclusion

Although the open-ended survey used in this phase of the study allowed participants to express their beliefs about creativity and the framework without restriction, the nature of the survey did not allow participants to express their perceptions in a clear and complete manner due to several reasons. Firstly, the participants might not be able to express themselves clearly in writing. Secondly, as this study assured anonymity, the survey did not allow follow-ups for clarification. Thirdly, the participants might be expressing their views based on what appeared in their mind at that moment. In view of these reasons, the findings of what the participants believed about creativity, creative individuals and the relevance of the framework in this study may not truly reflect the complete view of the participants. The findings here may only present what was perceived to be the most important by the participants captured in the survey. To further explore the participants' views about creativity and the framework, I conducted a series of one-on-one interviews with the participant-selected creative students and lecturers to probe into the following areas:

(a) the lack of nominations from lecturers
(b) proposed changes to the framework
(c) the reasons that caused the participants' concerns in using the framework
(d) ways to improve the framework

The findings of the interviews will be discussed in the next chapter.

CHAPTER SEVEN

PHASE III: The Interview

7.1 Introduction

Findings from Phase II, a survey on higher education students and lecturers' perceptions of creativity and the relevance of the taxonomic framework showed that the reference population agreed that creativity involves innovativeness and originality. Additionally, creativity is invoked by problems and is involved in the problem-solving process. There was a general awareness that creativity requires a range of strategies involving the reproductive and productive thinking, but they were unclear of the specific strategies involved apart from modification, combination of existing solutions, and generating an anew solution. The descriptions of creative individuals were generally tied to the context of teaching and learning. The overall findings revealed that the understanding of creativity was mainly focused on the Value and Mental propositions. The survey used in the preceding phase did not allow participants to elaborate their responses and did not allow me to follow up for clarification. Thus an in depth investigation of the understanding of creativity needed to be conducted.

The relevance of the strategies and the taxonomic framework were generally well received. However, following the participants' concerns about the rigidity in the use of strategies, I refined the framework's visual representation to indicate that there is equal value and significance assigned to each creative strategy in the framework as a problem-solving method. The impression of the unequal level importance assigned to each strategy and the prescriptive steps of the use of strategies through a pyramid design was changed to a semi-circular design.

The interview phase of the study, which is discussed in this chapter, was aimed at attaining three objectives. The first objective was to gain a deeper understanding of creativity among higher education students and lecturers. This was done by exploring the thoughts and understanding of creativity from a group of creative students and lecturers nominated by the survey respondents. The second was to explore how these creative students and lecturers exercise and demonstrate creativity in the higher education context. The third was to identify how the taxonomic framework may be useful for teaching, learning and assessment purposes. The creative student and lecturers' perceptions of creativity and feedback would be used to assess and further improve the framework's usefulness for educational purposes. These three objectives relate to research question three of this study, i.e., *what are the perceptions of the* *participant-nominated creative higher education lecturers and students on creativity and the relevance of the taxonomic framework for educational purposes?*

7.2 Methodology

This phase employed a qualitative design through the use of a series of one-on-one, semi structured interviews. The section below presents the details about the participants, instruments, and data analysis of this phase of the study.

7.2.1 Demographic Details of the Participants

The participants were 12 creative students and 12 lecturers nominated by the participants through the survey conducted prior to the interview (Phase II). An equal number of creative lecturers and students were selected from the Arts, Social Sciences, Science and Engineering faculties of the university. 33 lecturers (31.43%) who participated in the survey nominated a creative student and a creative lecturer. 205 students (61.38%) nominated a creative student, and 271 students (81.14%) nominated a creative lecturer. Four lecturers and four students who received the highest number of nominations from each faculty were interviewed. Table 7.1 presents the demographic data of the selected creative students and lecturers for the interview phase of this study. No parameters were set for the nominations as the study intended to explore how creativity was understood by the participants.

Table 7.1

Demographic Data of the Participant Selected Creative Students and Lecturers

Participants	Faculty	School	Nationality	Number of nominations (Percentage)	
				By students	**By lecturers**
SA 1	FASS	English	Sri Lankan	9/13 (69.23%)	3/9 (33.33%)
SA 2	FASS	Media, Language and Culture	Malaysian	12/20 (60%)	2/8 (25%)
SA 3	FASS	Economics	Malaysian	6/10 (60%)	1/3 (33.33%)
SA 4	FASS	Education	Malaysian	10/18 (55.56%)	3/6 (50%)
SS 1	FOS	Psychology	Singaporean	12/19 (63.16%)	2/5 (40%)
SS 2	FOS	BioScience	United Kingdom	12/20 (60%)	1/5 (20%)
SS 3	FOS	Pharmacy	Iranian	9/16 (56.25%)	1/3 (33.33%)
SS 4	FOS	Environmental and Geographical Sciences	Malaysian	9/17 (52.94%)	2/5 (40%)
SE 1	FOE	Mechanical Engineering	Malaysian	25/40 (62.5%)	1/5 (20%)
SE 2	FOE	Electrical & Electronic Engineering	Malaysian	16/28 (57.14%)	2/6 (33.33%)
SE 3	FOE	Civil Engineering	Malaysian	12/25 (48%)	2/6 (33.33%)
SE 4	FOE	Civil Engineering	Malaysian	11/25 (44%)	2/7 (28.57%)
LA 1	FASS	English	Malaysian	25/30 (83.33%)	2/4 (50%)

LA 2	FASS	Education	Malaysian	15/18 (83.33%)	2/8 (25%)
LA 3	FASS	Applied Psychology	United Kingdom	23/30 (76.67%)	1/5 (20%)
LA 4	FASS	Media, Language and Culture	Korea	19/27 (70.37%)	2/6 (33.33%)
LS 1	FOS	BioScience	Malaysian	13/20 (65%)	1/5 (20%)
LS 2	FOS	Pharmacy	Malaysian	18/27 (66.67%)	1/3 (33/33%)
LS 3	FOS	Computer Science	Malaysian	14/21 (66.67%)	1/4 (25%)
LS 4	FOS	Psychology	Spanish	10/17 (58.82%)	1/4 (25%)
LE 1	FOE	Mechanical Engineering	Malaysian	28/40 (70%)	1/5 (20%)
LE 2	FOE	Electrical & Electronic Engineering	Indonesian	10/19 (52.63%)	2/6 (33.33%)
LE 3	FOE	Civil Engineering	Malaysian	14/30 (46.67%)	2/6 (33.33%)
LE 4	FOE	Civil Engineering	Malaysian	11/30 (36.67%)	3/7 (42.83%)

Note. S=Student; L=Lecturer; FASS=Faculty of Arts and Social Sciences; FOS=Faculty of Science; FOE=Faculty of Engineering
Number of nominations=nominations received by each selected student and lecturer.

The creative students and lecturers were made up of a mixture of Malaysian and non-Malaysian. Non-Malaysians include participants from Sri Lanka, Singapore, United Kingdom, Iran, Korea, Indonesia and Spain. Student participants comprised 8 (66.67%) Malaysians and 4 (33.33%) non-Malaysians. The same composition made up the lecturer participants i.e., 8 (66.67%) Malaysians and 4 (33.33%) non-Malaysians. To approach the selected 24 participants, I sent them an email individually to inform them that they have been selected as creative student/lecturer. I then met them personally to invite them to take part in my study.

7.2.2 Research Instrument

A total of 12 semi-structured interview questions were constructed to ask the participants to (i) provide an elaborate definition of creativity, (ii) discuss criteria for recognising creative individuals, and (iii) provide their views about the relevance of the taxonomic framework for educational purposes. Additionally, the interviews were also used to clarify several issues that arose from the survey findings. These included the survey participants' concerns in using the framework (e.g., the concerns that the framework imposes prescriptive steps in creativity) and suggestions for changes to the framework (see APPENDIX D for the interview guide). The taxonomic framework shown to the participants was the same as the one shown to the reference population during the survey, except that the pyramid visul design has been changed to the semi-circular visual representation (see APPENDIX E).

The following interview questions were used to investigate the participants' definition of creativity:

1. *Is creativity an important characteristic/skill? Why?*

2. *What is the main purpose of being creative or using creativity?*
3. *In your opinion, is creativity a natural characteristic or a learned skill?*

These questions were aimed at expanding the understanding of how participants understood creativity beyond the data gathered through the survey. I focused on what the creative participants believed about creativity from the perspectives of functions and *teachability*. Secondly, the following questions were used to access participants' knowledge and awareness of how creativity can be manifested by individuals:

1. *Why do you think you might have been chosen as a particularly creative student/lecturer?*
2. *How would you rate your own creativity on a scale of 1 to 10?*
3. *What criteria or features do you use to rate your creativity?*
4. *What criteria do you use to rate the creativity of your friends, lecturers and others?*
5. *In the survey, there was a lack of nominations for creative participants among the lecturers. Why do you think that is so?*
6. *In the survey, there was a lack of nominations for creative students among the students. Why do you think that is so?*
7. *Would you like to further enhance your creativity? How?*

In addition, I used the question below to explore how the creative individuals themselves exercise and demonstrate creativity (this question was asked without presenting the framework to the participants):

8. *Could you share with me something (e.g., in teaching/learning/other activities) that you think you've done very creatively?*

Finally, I investigated the third objective of this phase i.e., to examine the creative participants' view of the relevance of the taxonomic framework using the following questions (these questions were asked with the framework presented in front of the participants):

9. *Do you think a framework like this will be useful personally and for your teaching/ learning? What are the possible uses of the framework?*
10. *How would this framework be useful outside the classroom?*
11. *Based on the taxonomic framework, which types of the creative strategies are you engaged in more frequently?*
12. *Do you think that this framework and supporting material need to be further improved? How?*

As is with semi-structured interviews, the questions stated above only served as a guide to the inquiry. The interviewees were prompted with follow-up questions whenever necessary to help them expand on their responses and to share their perspectives about creativity in higher education.

7.2.3 Data collection

During each one-on-one interview, I first explained the aim of my study, the objectives of the interviews and the estimated duration the interview might take. I informed the participants that the interviews would be recorded and their identity would be kept confidential. Once they were clear about the aim and procedure of the study, I obtained their written consent to be participants of this study. The interviews were conducted in a natural conversational manner that allowed me to collect information with as much flexibility as possible without constraining the participants' views and the goals of the research. Before each interview session ended, I made sure all interview questions were asked. I also explained to the participants on how the data would be used for my study. I asked the participants if they had any inquiries before each interview officially ended. Each interview took about one and a half to two hours.

7.2.4 Pilot Study

10% of the estimated sample size for my actual interviews were involved in the pilot study. The pilot study involved four participants (two students and two lecturers), aimed at assessing my data collection protocol and the suitability of interview questions, as well as identifying the necessary questioning techniques required during the actual interviews. After the pilot studies with four participants conducted on a one-on-one basis, I changed the order of the questions asked, and the way in which the questions were structured to ensure comprehensibility of the questions. As a result of the pilot interviews, I prepared more questions that may serve as prompts to elicit more information from the participants.

7.2.5 Data analysis

The data gathered from the interviews was analysed using thematic analysis (Braun & Clarke, 2006). Once I had transcribed the interviews, I re-read the transcriptions to familiarise myself with the content of the data and to gain an overall understanding of each participant's notions of responses. After that, I coded the interview transcripts according to the three areas of investigation i.e., (i) definition of creativity (importance, functions of creativity and creative individuals), (ii) demonstration of creativity, and (iii) relevance of the taxonomic framework. Data relevant to the definition of creativity was analysed without a predetermined set of themes. Within each area of investigation, I collapsed codes that belong to the same themes. Unlike the survey where codes related to the definition of creativity were assigned to the five propositions i.e., Mental, Trait, Context, Outcome and Value on the taxonomic framework, in the interview, codes that belong to the definition of creativity and creative individuals were collapsed into themes that were not predetermined but emerged from the data.

Data related to the participants' creative practices (demonstration of creativity) was analysed according to the six creative strategies in the framework i.e., *Replicate, Imitate, Transfer, Characterise, Transform* and *Create*. Any strategies that did not reflect any of these strategies would be coded accordingly. Data related to the relevance of the taxonomic framework was analysed based on the uses of the framework and improvements for the framework. For uses of the framework, I specifically assigned the codes to teaching, learning and assessment. For improvement of the framework, I developed themes based on the codes that emerged from the data.

Six transcribed interviews (three lecturer data and three student data) were assigned for inter-reliability coding. The Cohen's Kappa test was employed to determine the level of agreement in the codes derived by me and the coder. There was good level of agreement between our interpretation, k=.84.

7.3 Findings

In the section below, I will present the findings according to three areas: (i) definitions of creativity, (ii) demonstration of creativity, and (iii) relevance of the taxonomic framework perceived by the participants. I will present the student and lecturer data from all three disciplines collectively, as there were no apparent differences found between findings from students and lecturers, and between disciplines. When there are views that are particularly expressed by either the students or lecturers, I will clearly state where these views are coming from i.e., the students or lecturers.

7.3.1 Definition of Creativity

Similar to the survey, I explored the creative students' and lecturers' perception of (i) the concept of creativity and (ii) creativity as an individual's characteristics.

7.3.1.1 Definition of the Concept of Creativity

The participants' beliefs about the concept of creativity were gathered from their perspectives towards the importance and the purpose of creativity. The interview data reveals that all participants unilaterally agreed that creativity is an important characteristic and skill to possess. From the analysis, themes that relate to the definition of creativity are creativity is related to problem solving, creativity is facilitated by expertise and experience, creativity is stimulated by inspiring communication, creativity provides a sense of fulfilment, creativity produces something innovative as well as creativity as a learned vs and inherited ability.

7.3.1.1.1 Creativity for Problem-Solving

In the interviews, six students and nine lecturers related creativity to problem solving They primarily emphasised that creativity is vital to manage real life situations and problems, for which people do not have ready-made solutions or strategies (*solve ill-defined problems*). The participants associated creativity as an essential skill to constantly develop new ways of working due to the unpredictable and rapid technological advancement, and for solving global humanity issues such as poverty. Therefore, creativity was deemed important for uncovering novel approaches to problems and improving existing situations. The quotes below explain some of the perspectives of the discussion above:

> *I think the purpose [of creativity] is to solve problems. I feel the changes are too quick, and the other day our lecturer told us that what we learn right now may not be useful already by the time we graduate, because there are just so much advancements, they change the way we work and skills we need. <u>If what we learn cannot be used in the future, that's when creativity comes in I guess, to think of new ideas.</u>* (SA 4)

> *Creativity is very important, because with creativity, you can surely think of some ways to deal with issues, whatever issues. I feel creativity is…because new technologies are coming almost every second and these kinds of developments will change lots of things, so we don't know what's going to happen tomorrow. So <u>when you don't have a solution that you know, creativity will just nail it.</u>* (SS 2)

> *If you look at the outside word right now, creativity is so important because everything is about creativity<u>. You want to keep up with technology, creativity; you don't want to be replaced by technology, you better be creative to solve problems.</u> There are lots of problems for you to solve. The more advanced things are, the more creativity you need because more problems for you to solve.* (LA 3)

> *I feel, if <u>creativity is not there, there is no way we can solve complex problems now.</u> How to solve poverty, how to solve social problems…all these problems simply need people to be creative.* (LE 2)

However, when it comes to problem solving in the teaching context, there was an apparent concern among the lecturers about the simulated problems commonly used in class. Seven lecturers differentiated real life problems from simulated problems that are often used in education. These simulated problems are those that already have existing solutions, thus, students could be directed towards a single or pre-existing solution. Based on the lecturers' accounts, it may be inferred that real-world problems were rarely used in the context of teaching and learning. This would be an issue that required attention and immediate solution in the context of higher education. The following quotes reflect this concern:

> *You know we have a set of problems for students to solve – case studies. But these case studies are pretty straightforward, you analyse the case, but I have already taught them the case, and the case is clear cut – either this symptom, that symptom, or combination of these. Not much complications, and here I'm talking about media and culture. When we deal with culture, it's difficult to be so clear cut. It's just not real. They know what the possible solutions to those issues.* (LA 4)

> *If we are talking about solving real problems, creativity is important… But in class, the problems normally don't stimulate creativity. They are not real problem, you get what I mean? It's very structured. In class, you learn things in a very simplistic manner. You learn in a stepwise manner in terms of the level of difficulty. The uncertainties are very few. Problems given in the class is very structured. You know how to solve it and students are expected to follow that. If you look at life problems, they are not just one problem. It may manifest as one problem but due to many factors.* (LS 4)

> *Creativity is important because it's all about solving problems nowadays… That's why creativity is needed because it can solve issues, can improve current situations. We also give problems for students to solve, engineering is about problem solving, right, but we teach them a concept, then they apply the formulas of the concept.* (LE 1)

Within their views towards creativity and problem solving, they provided elaboration on the need for the ability to *generate multiple solutions* and *manipulate knowledge and resources* to produce solutions.

Extending their position on problem solving as relevant to creativity, eight students and nine lecturers emphasised the importance of *generating multiple solutions*. The emphasis on being able to generate multiple solutions indicates that both students and lecturers acknowledged that creativity is needed to find the root cause of the problem and think of multiple solutions from different perspectives. Additionally, the ability to generate multiple solutions was seen important to address issues when an individual was stuck at a situation when one solution does not work. Because of the awareness of this importance, the lecturers recognised the need for creating opportunities for students to invoke multiple alternatives and perspectives, instead of teaching or encouraging one standard solution. The quotes below explicate this point of view:

> *It's [creativity] to help yourself in future problems, I think that's the most important part.*

You cannot just know one solution for everything. If you can't use that [solution] <u>you have to find other ways to solve the problem</u>. (SA 1)

I always have this problem – I can think of one way or one idea, then I get stuck. This happens in my essay and also in lab work, <u>I know I need to think from more angles</u> to get hold of the root issue, but that's not too easy anyway. I think it's very important to be creative, <u>because you just need to have more ideas, we are now dealing with future problems, so one [solution] is…I don't think is enough</u>. (SS 4)

…in our class I think getting students to think of many ideas is something key…if we give a situation, ask them to suggest some ideas to solve it, <u>they can't think of just one and that's all, they need to think of alternatives</u>…maybe can be done through our activities, not sure, focusing on actual problem, not formula problem… just thinking aloud. (LS 2)

For example, I'm sure you know F=ma (Newton Second Law of Motion). So what we do is we teach this, then give them a problem to apply this F=ma. Although the problem is somewhat real, but the application is already fixed. Can we use another formula? Are there any formulas? We don't talk about all these. I said earlier, one problem has other issues. But we don't talk about these. <u>We should get them to produce more ideas to be honest.</u> If they do not know F=ma, how many ways can they think of to solve this? Can they think from non-engineering perspectives to solve this? The wider you see the more you understand the issue actually and preempt other possible problems. That's what we need to do in education I suppose. (LE 1)

Four students and six lecturers further asserted that solving real life problems is not about merely recalling and applying the previously acquired or existing knowledge and solutions. Instead, they argued that it is about reorganising and reconceptualising existing information and knowledge to innovate possible solutions (*manipulate knowledge and resource*). Specifically, the participants recognised that creative strategies to solve problems include the use of existing knowledge and solutions (productive thinking) and the breaking of conventions to innovate novel solutions (reproductive thinking). The quotes below are two examples that portray this view:

…sometimes the essence is <u>to break old thinking</u>. We can (be) stuck and stuck and keep going back to the same point because we are not breaking that old ways of thinking. If we break, we immediate find a way. (SE 3)

If I give you a solution and ask you to think of other purposes for this solution, can you think of some? Creativity is like that. <u>You use what is available, but must be able to change perspectives, create new hypotheses</u>. (LE 3)

...So you need to be creative in tackling all these problems…by <u>rethinking and repurposing certain resources or solutions</u>. (LS 4)

…I feel it's like unlocking the door. Sometimes we can't open the door and still keep turning the same way, because that's what we know…but once we try turn the other way round, the door is immediately unlocked. So it's about changing that perspective, the thing is we are always stuck with what we already know. (LA 1)

7.3.1.1.2 Creativity facilitated by Expertise and Experience

Three students and seven lecturers expressed the belief that expertise and experience mediate creativity. They explained that knowledge is crucial to help develop their creativity in teaching and learning. The lecturers acknowledged that experience guides them to be creative in meeting students' learning needs.

I feel I'm more creative now (Year 3) compared to last year. I think I'll be more creative when I'm doing master's later, it's our Year 4. I think it's the knowledge and experience I gained…making me more creative...the design engineer told me, for him to reach that level takes him more than 10 years or so…so I guess knowledge and experience is the thing, you know what's going to work and what may be not. (SE 3)

I learn to be creative mostly from my experience…after so many years of teaching, well I've been teaching more than 15 years, so I know the content so well, I know what works for students and what don't. It's all through trial and error. (LS 1)

I've been teaching for so many years, I teach the same modules over and over again till I know how to explain a concept in different ways to help students learn better. I just know how to tweak the slides and activities to suit different students. Over the years you just gain that knowledge and proficiency. (LA 4)

Experience also develops expertise which then facilitates one's judgment and decision making in any creative attempts in teaching and learning. It guides them in predicting the success of plausible solutions.

I think when you become an expert, you'll be creative. Of course to be an expert you need to gain enough experience. When you're a master of something, you can roughly estimate things and it's easier to be creative this way. (SA 2)

When you do things over and over again, you kind of able to gauge whether that approach is going to be successful and what may make it fail. (LS 2)

For us, experience is so important because when I know the success rate, I know how to be creative. (LE 4)

7.3.1.1.3 Creativity for Inspiring Communication

Five lecturers saw a need for educators to be creative and inspiring in talking about learning opportunities, content and tasks. They believed that through enthusiastic and motivating communication, educators will be able to inspire students to be creative. The quotes above reflect the belief that creativity helps stir enthusiasm and inspire virtue, particularly in terms of social responsibility, in students. The quote below illustrates how creativity is seen as an essential tool to inspire students:

> *Creativity is <u>to inspire students to see things differently and to inspire them to apply concepts</u>...also to inspire them to contribute to society. They will be more innovative and even more confident after being inspired that they can do more.* (LE 4)

> *Creativity is about inspiring people. In teaching we are not preaching, we inspire students to be creative, to serve the community. To get them to feel that in them, it really <u>depends on the us to plant that seed in them, to tell them they are capable of doing much more</u>.* (LA 4)

> *Because of creativity, I know how to <u>say the right things to motivate students, to stimulate their passion in what they do. I also use different examples to inspire them</u>. I teach global food security, and the most important for them to connect to this module is tell them <u>they have the power to enhance the quality of life</u> though improving nutritional advice.* (LS 1)

7.3.1.1.4 Creativity and Sense of Fulfillment

All 12 lecturers were convinced that creativity is important to maintain one's motivation and sense of fulfillment as a lecturer because such satisfaction enhances their wellbeing. The lecturers' satisfaction as a result of being creative mainly came from students' enjoyment in learning. The primary drive to be creative was the lecturers' intrinsic motivation, which helped them feel a sense of fulfilment upon accomplishment of each creative attempt. The quotes below exemplify how creativity and self-fulfillment are interconnected:

> *<u>Creativity really gives you different satisfactions</u> when you are engaged in creativity activities rather than going through like a very boring routine. I can't stand doing the same thing again and again…So I do this "Academic Football" with my students. It's different than the typical quiz. Students enjoy it very much, and they learn better, and I enjoy it even more.* (LS 2)

> *Creativity can do <u>something to your wellbeing</u>…I feel…it helps lower our stress and makes us feel happy about what we are doing.* (LE 2)

Creativity gives me a lot of satisfaction. You yourself must feel the need for creativity first, then you'll immerse yourself in deep thought. I always think of how to teach something and how to explain things. But that gives me a lot of satisfaction, and if the students love it, I feel really happy. In a way creativity makes me satisfied and happy with what I do. (LA 1)

7.3.1.1.5 Creativity for Producing Something Innovative

Five lecturers and six students believed that creativity is important for individuals to produce something innovative, concurring with the survey findings. Innovativeness here refers to the quality of being new and unusual. Innovativeness helped them gain recognition and to create a positive impression on others. The quotes below indicate this position:

Creativity, yes it' s important…it's important to guide us through making innovative ideas. We need innovation nowadays, make things different, make us different…we all need to impress people, that's how we can be different from the rest. (SS 4)

The purpose of creativity is to create something unconventional, not the same, old boring ideas that are so easily predictable. (SA 1)

Creativity helps to make something that is out of the box, it's important to stand out, and newness helps us stand out…so this creative thing is important to come out with unusual ideas, these ideas let people notice us, recognise us. (LA 4)

The whole idea of creativity is to problem solve, and why we problem solve, is to get something novel something new that serve better solutions. (LS 2)

7.3.1.1.6 Creativity as a Learned and Inherited Ability

The interview data reported that all 24 participants strongly believed that creativity is a combination of learned and inherited traits. Specifically, they indicated that learning, formally and experientially, nurtures creative abilities. They recognised that some people tend to be more creative but to develop the skill of creativity further, there needs to be opportunities to be creative. These opportunities and support include experience, knowledge, observations of creative actions, family support, inspiration from others, modelling others, and through teaching and learning using a creativity framework or model. The quotes below present the view on the *teachability* and *learnability* of creativity:

I think people can be born creative and for others you can see that potential in them *but it won't happen if they don't learn. You need to learn to harness that power, even if you are a strong person in nature but if you don't exercise and unblock that nature, you'll lose them……creativity can be learned through experience…through reading books, through observation, through literally see other creative people and just try to do the same or try to mould it to your own way.* (SS 2)

I think it's both [born and learnable]. People can be creative naturally, but they also can improve. No matter which creativity you are in, you can be low and can high, and the level can keep increasing. For me, my mum always encourages me to be creative. I'm from Singapore and it's very competitive, so my mum keeps telling me I need to be creative. If people don't mind you being creative, you'll be creative. (SS 1)

Certainly both [born and learnable]. We have to admit that some people are more creative than the others, but it's still a skill that you can empower and manage. There are so many ways to improve creativity – you can be inspired by others, you can take creativity courses and so on. (LA 3)

It's both [born and learnable]. I teach TRIZ to my students. This is a framework for creativity in engineering. So I believe you can teach creativity. [LE 2]

7.3.1.2 Understanding of Creative Individuals

In this section, I further examine the definition of creativity from the perspective of how participants identified creative abilities and characteristics in themselves and in others. The themes that emerged from codes related to creative abilities and characteristics are presented in Table 7.2. The table presents how students and lecturers recognised themselves as creative individuals ("Self-Recognition" column) and how they identified creative students and lecturers ("Recognition of Others" column).

Table 7.2

Participants' Identification of Creative Abilities and Characteristics

<table>
<tr><th>Creative Abilities and Characteristics
Participants</th><th>Self-Recognition</th><th>Recognition of Others</th></tr>
<tr><td>Students</td><td>Wide knowledge and experience</td><td>Idea materialisation</td></tr>
<tr><td rowspan="4">Lecturers</td><td>Teaching with creativity</td><td>Challenging students</td></tr>
<tr><td rowspan="2">Teaching for creativity</td><td>Performance-based outcome</td></tr>
<tr><td>Resourcefulness</td></tr>
<tr><td>Impactful experience</td><td>Openness to new ideas</td></tr>
</table>

7.3.1.2.1 Students' Perceptions of Creative Individuals

The students identified themselves as *having wide knowledge and experience* as creative abilities and characteristics that they saw in themselves, and the ability to *materialise creative ideas* and *giving others an impactful experience* as qualities of creativity in others.

(i) Wide Knowledge and Experience

Concurring with their initial explanation that knowledge and experience contribute to the development of creativity, eight students held beliefs that their wide knowledge and experience from various disciplines led them to perform at greater creative capacity. They believed that knowledge led to the ability to draw resources from different disciplinary areas and experiences. The following quotes highlight how knowledge was perceived to fuel creativity:

> *One thing I have is I yearn for knowledge. I want to know about different things, not just in engineering, also in other things. I join different societies… This knowledge makes me aware of the different resources that exist. My friends...lack of these experiences and knowledge. So like last year I had a set of tools that I know that I know completely what they are for, instead my friends do not even know these tools exist. That's why I think having the drive to learn more things is what makes them think I'm creative.* (SE 4)

> *I feel it's my knowledge. Knowledge helps me to know what is out there and I can use them as a foundation for my innovation. If I do not know what is available for me, then it's not to say you can't, but it takes much more effort to be creative.* (SS 4)

Furthermore, having wide knowledge and experience allows for interdisciplinary knowledge application. The participants believed that having wide knowledge enabled them to integrate knowledge from different disciplines, and also apply knowledge from one discipline to another.

> *I would say it's my ability to combine wide knowledge, and based on my experience, I integrate different things that are useful. From there I think I'm exercising my own creativity, because I need to know how to make all these different things harmonise with each other. I can manipulate knowledge from one place to suit another as long they harmonise.* (SE 2)

> *I guess I'm good at conceptual blending. It's like you learn things from one frame of reference then you apply it in another frame of reference. So you combine these different experiences you have. Like I used to work in public relations a big part of that was to come up with a creative campaign for our clients. A lot of times I found that when I read poetry or books on the process of writing prose, poetry and fictions, I could apply that to public relations. So I have these two separate worlds and have nothing to do with each other but I take some concepts from something that I learned.* (SA 1)

(ii) Materialising Ideas for Actual Value – make ideas happen for a functional value

When recognising creativity in others, six students indicated that the ability to execute a creative idea is a vital ability in a creative individual. A creative person does not only come up with good ideas but makes the ideas materialise through actions in the real world. Without idea materialisation, an idea remains as an abstract thought without an actual functional value. The quotes below illustrate why being able to materialise an innovative idea is an important quality for creative students:

> *Sometimes I just come up with dumb ideas – ideas that I don't even know if they are working or not. But I make them work. So I think it's the creativity that drives the idea, but also creativity that makes the idea work...if you ask me how I think someone is creative, it would be someone who can make their ideas really work.* (SE 3)

> *When the person can see their ideas through to full realisation, I think the person is creative. When we do creative writing, sometimes the concept is creative, but in the end, when the story is complete, it may not be as creative. There are lots of reasons, it could be because of the market demands, potential acceptance from the readers and so on. Two ways, you either think through all these factors when you plan the concept, or you don't compromise but to stick with your original creative concept. Either way, as long as the person makes sure the creative idea becomes a reality, not just some kind of imagination hanging in the head that no one knows, then it's really creative – the idea really has to work.* (SA 4)

(iii) Giving Others an Impactful Experience

Seven students viewed that creative lecturers create an impactful outcome to academic and non-academic learning. This is an essential dimension that the students used to gauge a lecturer's creative capacity. The quotes below give a clearer depiction of how creativity and impact are intertwined:

> *I feel that while the lecturer is creative, the creativity must also have an impact on students. This is a very good example. She [the lecturer] showed a simple diagram full of lines and she asked us to find the star. None of us could find the star and eventually after 20 minutes someone got it and I got it too. Then she asked us how it felt to find the star, and we told her it was frustrating as it took so long. Then she said that the star is in all students. It takes a long time to identify and it's painful but it's worth it. My whole class was like whoaaa...* (SA 4)

> *For me to say a lecturer is creative, the lecturer must leave an effect. We have a lecturer in my first year, he took all of us to the jungle to teach a topic on deforestation. He let us play in the jungle, just play, he didn't ask us to do anything in the jungle. After that in the class, he asked us how much we enjoyed playing in the jungle and asked*

us how we feel if jungle will be destroyed. I think that's really powerful for us to feel the sadness of deforestation and appreciate nature more. (SE 1)

My personal tutor is creative I would say. I shared with her a lot of my personal issues, and she always has her way with me. She will use her own examples to advise me. Some of her signature phrases still help me through my life till now to make me a positive person. (SS 3)

7.3.2.1.2 Lecturers' Perceptions of Creative Individuals

The lecturers recognised several creative characteristics in themselves, including possessing the ability to *teach with creativity*, *teach for creativity* and *creating impactful experiences for students*. Similarly, a few qualities were identified as creative strengths in others, these encompassed the ability to *challenge students* appropriately, *demonstrate creativity in academic performance*, *openness to new ideas* and *resourcefulness*.

(i) Teaching with Creativity (Teaching Creatively)

All lecturers identified features of teaching with creativity when they rationalised why they were nominated as creative lecturers. Two main features of teaching with creativity emerged from their descriptions i.e., *innovate teaching* and *demonstrate creative ethos*. Most of the lecturers (ten out of 12) indicated that they innovated their teaching by using different methodologies and strategies to engage students in learning. These methodologies included using technologies and apps, field trips and game-based learning. It was apparent that when describing creative teaching, the lecturers focused only on their expressions of creativity but was not about their students' demonstration of creativity. The quotes below show how the lecturers perceived innovative practices:

I use different ways to teach. Sometimes I use role-play, case study and also Kahoot, you know Kahoot right, to make my class interesting. (LS 1)

I took a course called game-based learning before and I got my students to play games in the class. I'm not so good in the mobile one (mobile games), so I do simple ones like board game, alibi, music box…they get very excited, and you can see them wanting to answer those questions. If I ask them to answer questions, they all keep quiet. (LS 2)

I do different types of work with them. I took them out to feel nature, invited real engineers to share ideas and knowledge, get them to present. All of these are to help them understand what I teach better. (LE 4)

I'm creative in the sense that I innovate things a lot. I don't do the same thing again and again. I created different activities like flipped classrooms, blended learning,

> *Kahoot. I can see* <u>*students getting more interested and more engaged and do better in their quizzes*</u>*.* (LA 2)

Seven lecturers believed that it was their *creative ethos* that has made students identify them as creative educators. They described *creative ethos* by alluding to personal characteristics such as convictions to creativity through communication, courage to try out different ideas, encouragement for creativity through risk taking and problem solving, and recognition for students' creative attempts. Similarly, their accounts did not reflect their intention to develop student creativity. The quotations below illustrate creative ethos:

> *I think it's* <u>*my mannerism*</u>*, the way I speak, the way carry myself. I also* <u>*encourage them [students] to be free, and as uninhibited as they can*</u>*.* (LA 3)

> *I always try to be different, try out different ideas in the class, and sometimes* <u>*I even tell them I'm not sure if it works, but I want to try to find out.*</u> *I'm not sure, may it's because of this, they feel I'm creative.* (LA 2)

> *I guess…I always tell them* <u>*to take guesses*</u>*, it doesn't really matter whether it's right or wrong, but I say to them* <u>*they need to take some risks*</u>*, otherwise inventions never happen…we are dealing with Science – it's inventions, discovery – all need some risks to be taken for it to happen...I emphasise a lot on that, and I* <u>*just speak with lots of conviction I believe*</u>*.* (LS 1)

> *…sometimes* <u>*you just need to recognise your students' creative attempts, so they feel they want to try doing things different again*</u>*...and recognise…I mean say it to them exactly [explicitly]…you will see the difference, trust me, they will be more brave in their ideas. I teach a module on soil mechanics and we talk about effective stress and movement of water through soil…so lots of problem solving…engineering right…they can come up with different ideas, sometimes a bit too far-fetched like they would talk about Sci-Fi, but you can see the effect on them if you encourage them, better than them retelling me what's already in the slides.* (LE 2)

(ii) Teaching for Creativity

It is important to highlight that only one lecturer attributed his nomination to his ability to teach for creativity. This lecturer mentioned that he nurtured students' creativity by exercising flexibility and offering choices to students in their assignments. The choices offered to students was believed to have allowed them to gain ownership of their learning, which then led to their creativity. Unlike teaching with creativity depicted earlier, teaching for creativity, portrayed by this lecturer, has a deliberate intention to allow students to demonstrate creativity. This description is reflected in the quote below:

I am open minded towards different forms of creativity may it be in the arts or science. Maybe that's because of my multidisciplinary background. I also enjoy p-creativity [personal creativity] very much. As an educator I am excited when students can achieve things they never could before...in my assignments, <u>I don't prescribe, I set the parameter, but they [students] are allowed to choose their own topics that they'd like to explore. Giving them the choice is important</u>…we need to be open about this...more so it's their own learning…when I do this, you can see them producing creative solutions and ideas because <u>that's the learning outcome I want to see by giving them the choice</u> – it's a choice for them to demonstrate their learning in any way they want. (LA 4)

(iii) Creating Impactful Experience for Students

Six lecturers associated their creativity with the impact they have on their students and their learning. Impact refers to the impression the lecturers or the lessons made on the students. This resonated with students' belief that a creative lecturer creates an impactful experience for students. The quotations from the lecturers below give a better understanding and perspective on the kinds of impact aspired for by the lecturers:

I try to make learning <u>meaningful, practical and memorable</u>. (LA 4)

I took them to the park nearby here to let them appreciate the jungle. I let them enjoy themselves, play in the mud – the point is to get them to appreciate, once they enjoy it, and I told them what if the jungle is to be destroyed…<u>now because they have enjoyed it, so they felt it's terrible to destroy the jungle</u>. Otherwise to them jungle, jungle la [jungle is just a jungle] but I also make sure they really appreciate it, otherwise it's like me "syok sendiri" [only me being indulged in my creativity]. (LE 4)

It's too important for the students to feel about the content. <u>It has to stay there in their mind for a long time.</u> I don't mean it to be fancy, but there must be an impact! (LS 1)

While both students and lectures associated "impact" with a creative lesson, it is important to note that what it means by "impactful" needs to be understood by both students and lecturers in the same way. Otherwise the lessons might not be considered a creative or an effective one.

(iv) Challenging Students

To recognise creative lecturers, three lecturers believed that students must be challenged. The purpose of constantly challenging students' thinking is to prepare them to become problem solvers. The lecturers believed that the process of challenging students to be creative requires proper scaffolding appropriate to the students' level. The quotations below explain why setting challenging tasks for students is an important creative capacity lecturers should practice:

> *It's important to make students think. <u>They have to be challenged all the time</u>. We <u>don't need to ask something too difficult</u>, no point. We need to <u>stretch and challenge them</u>. They will go beyond their ability. Trust me, human's potential has no limit…<u>I don't mean stretching them without supporting</u>, sometimes some prompts from us is important and powerful.* (LA 2)

> *I believe students <u>must be challenged to expand their capacities</u>. As long as the <u>challenge is appropriate to their level</u>, it will help them grow. Lecturers need to do this more often…they will be challenged at work later when they have problems to solve.* (LS 3)

> *Lecturers must set a high expectation on students. So we need to <u>set challenging tasks for them to do</u>. Give them some problems to solve. More so if we don't challenge them, they will feel bored and meaningless. I see creative lecturers as those who challenge and question students appropriately, <u>so that they are used to challenges and issues in the future.</u>* (LS 1)

(v) Performance-Based Outcomes

When identifying creative students, student performance is a benchmark for lecturers to determine if they are creative. Findings showed that the lecturers (nine out of 12) predominantly related creativity performance assessment to student presentation of solutions in completing any assigned tasks. The quotations below illustrate how creativity is recognised and assessed through presentations:

> *Normally what we look for is like whether the presentation is clear, whether the points are arranged in a logical flow...and if they are doing posters, we look at whether the poster stands out as compared to other posters...meaning if it brings out the points clearly...or if you have like ten posters, where are your eyes? You are browsing through all the posters and immediately look at that poster, so that's an outstanding poster. I think there is element of creativity there...so presenting facts in different ways, I guess is creativity.* (LS 2)

> *Usually through their presentations. I'd look at how they present their information. Usually I also see if their slides are clear or very cluttered, or they will use different images or visuals to make their presentations creative…we don't really have a guide to assess creativity, when we see it, we know it.* (LA 4)

> *I'll get my students to do presentations. Every student presents their points differently. Some are interesting, some are not. I tend to look at that, but of course it has to be logic as well…no we don't have any criteria for creativity to help us assess.* (LA 2)

> *I don't think we have any assessment to assess student creativity. It will be good to*

> *have one, but I just know that a particular idea is creative. I can do this from their presentations – how they get their points across and how they use visuals.* (LE 2)

When asked about their criteria for assessing creativity, the lecturers did not have any predetermined criteria to assess creative behaviours. Although they declared that they used intuition to assess students' creative output, they also specified features such as clarity and presentation layout. It is evident that the lecturers were looking for certain important aspects of creativity such as innovativeness and appropriateness of an output (presentation) created by the students. However, this situation also suggested that the lecturers were focused more on the creativity in appearance and the presentation style rather than the creativity of the solutions.

(vi) Resourcefulness

When identifying creative students, three lecturers paid attention to the students' *resourcefulness* in solving problems. These resources included connection and facilities. The efforts put into tackling challenges is appreciated by the lecturers. The quality of being resourceful was deemed crucial to support students to visualise all possible ways to achieve their goals even in constrained situations. The quote below explains why students' attempts on being resourceful is a valuable creative characteristic for students.

> *I asked students to organise a talk and they need to get a few people in. I didn't tell them who to contact, I didn't give them any contact. They just find a way to do it – getting sponsors, speakers…all by themselves. They are resourceful, <u>they know where to find resources</u>. I think that's important for students.* (LA 3)
>
> *I think students need to be very resourceful nowadays. For example, if there's no fire in the room and you need to eat, find ways to get fire to cook. <u>You need to be resourceful to solve problems</u>.* (LS 2)
>
> *I think I will see whether they [the students] really try to solve a problem. Like one of my FYP [Final Year Project] student, he was trying to interview his participants but he had problems because of some issues…when he came to me, he told me he has tried to propose doing phone interviews, Skype interviews etc…although he came to me to seek my advice, to me that's <u>very impressive because that shows he has tried different ways to solve the problem</u>. To me if I were to say which student is creative, I'll look at this quality.* (LE 4)

(vii) Openness to New Ideas

Students who are open and receptive to new ideas *(Openness to new ideas)* were appreciated by two lecturers when it comes to identifying creative students. Openness to new ideas refers to the willingness to accept new ideas and experiences. It was seen to be an affective trait that helps individuals to adapt to changes and uncertainties. As such, when students are receptive to new ideas, they are more open to trial and error and are more interested in seeking sensation and different experiences both individually and collaboratively (*get along with people much better)*. More importantly, it also helps them to be more tolerant to ambiguity, as vagueness and uncertainties are often embedded in real-life, everyday problems. The quotes below reflect how students' openness to new ideas is appreciated:

> *I think if I see that student is open to new ideas, can work with different people who give different ideas, then I will think that's a creative student. Because when they are open, <u>they don't mind experimenting</u> right, <u>they don't mind exploring feelings</u> you see. <u>They are more okay with unpredictable things</u> – this is life right.* (LE 3)

> *Students who are creative are those very open-minded. This way they <u>get along with people much better.</u> These types of students, they are <u>more expressive</u>, many times they look for <u>new experiences because that can give them the chance to feel different experiences.</u>* (LA 1)

7.3.2.1.3 Barriers to Being Creative

One of the puzzling aspects of this study, was the lack of nomination from the reference population (lecturers) for creative students and lecturers. Investigation into this matter suggested that lecturers were not able to identify creative students and lecturers for several including (a) teaching large classes does not allow for identification of creative students, (b) formal examinations used in large classes limits student opportunity to exhibit creativity, (c) the focus is more on learning subject matter content rather than developing skills and creativity which are usually left to incidental learning, and (d) the lack of knowledge on how other lecturers teach in the class. These reasons are reflected in the quotes below:

> *Some classes are really big, more than 100 people in a lecture, especially Engineering. It's pretty hard I suppose. It's difficult to do creative activities, so it's probably a bit hard to know who is creative.* (LE 2)

> *It's normal to do quizzes and exams with students because it's large (the class), it's easier to mark. So these formal examinations don't let them express creativity much.* (LS 1)

> *Most of the time lecturers focus so much on teaching the content, and I do too to be honest, because mastering the content is so important. But too much focus on that…I think it does no good to creativity...but I do guess creativity may still happen, just less.* (LA 2)

> *I guess probably it's because not everyone know how to be creative and how to make people creative? Creativity is not a simple thing you know, it's complicated.* (LA 1)

7.3.2 Conclusions on the Definitions of Creativity

In conclusion, echoing findings from the survey, creativity was perceived by the creative participants as the ability to produce an outcome that are innovative and the ability to solve problems. However, the creative participants extended the view of problem solving by explaining that creativity is important to manage real life situations and problems that do not have an existing solution and to generate multiple solutions to a problem especially when an existing solution does not work. Additionally, creativity involves not only applying existing knowledge, but also reconceptualising existing knowledge and resources to generate solutions (manipulate knowledge and resources). Unanimously, creativity was seen as a skill that is both inherited and learned. Although individuals were born with different levels of creativity, an individual's creativity can be enhanced through formal learning and through experience. Additional views towards creativity gained from the interview data included the perceptions that creativity could be facilitated by experience and expertise, creativity could inspire enthusiasm and virtue that in turn contribute to the community, and creativity creates a sense of fulfilment to the creators that could lead to better wellbeing.

When conceptualising creativity as a quality of an individual, concurring with the survey findings, creative lecturers were appreciated for their ability to teach creatively by using multiple innovative teaching approaches. The creative participants added that creative lecturers are ones who create impactful learning for students, teach for creativity and challenge students. Findings from the interviews revealed that creative students were perceived as one who possesses wide knowledge and experience as well as the ability to materialise creative ideas so that these ideas have an actual functional value in reality. Creative students were also viewed as ones who are resourceful and open to new ideas experiences. Moreover, students' creativity was often assessed based on students' creativity demonstrated in their presentation, specifically in terms of their presentation style and layout, instead of focusing on the creativity of the solutions produced by the students.

7.4 Demonstration of Creativity

In this section, I examine how the creative students and lecturers demonstrated creativity based on their explanations at the interviews. Table 7.3 summarises the use of creative strategies among the students and lecturers. Through a deductive analysis, I coded the participants' creative practices against the six strategies in the framework i.e., *Replicate, Imitate, Transfer, Characterise, Transform* and *Create*. If there were creative practices that did not reflect these six strategies, they would be coded accordingly to indicate these additional strategies. The strategies most frequently mentioned by the participants reflected *Imitate* and *Transfer*. *Replicate,* and *Transform* were less employed. The participants' accounts of their creative practice did not reflect the *Create* strategy. It could be deduced that the more frequently used strategies were those closer to reproductive thinking.

Table 7.3

Participants' Use of Strategies for Creativity

Creative Strategies	**Students** **Examples from the interviews**	**Lecturers**
Replicate (To exactly reproduce an existing solution) S = 3 L = 2	*I've seen on YouTube how to do closed stich crotchet. So I follow the procedures.* (SA 4) *I followed the steps in a cook book to make Sushi.* (SE 3)	*I saw him [a colleague] doing this and it really makes the students appreciate nature, so I do the same for my module.* (LE *3*) *I've seen other lecturers using film theory to teach poetry. I find it creative so I tried it with my students.* (LA 1)
Imitate (To model after an existing solution) S = 6 L = 4	*I use a rice cooker to cook because I'm lazy to clean the stove. Since stove uses heat, and rice cooker also uses heat, so I think it will work.* (SA 2) *Instead of using 3D printing which is not available here, I just do a model, but I made changes so that the model can see through the organ and also allow people to touch it. I'm copying the 3D printing idea but I actually made changes to it.* (SS 4)	*When I studied in the US, when I was in the 8th grade, I had a teacher who played a game called academic ball, something like this, but it was sort of like the American football. So I adapted it from American football to regular football.* (LS 2) *When I was attached to the industry, I always tried to make some minor changes to the water tank model I created. The changes are actually because the usual standard model won't fit in some of the residential measurements.* (LE 2)
Transfer (To borrow ideas from another discipline) S = 4 L = 5	*I use what I learned from International Relations to apply into my creative writing.* (SA 3) *I play a few instruments, and I always apply musical theory to sound engineering that I took outside. It's fascinating, they are differences and similarities. But those differences can be integrated together.* (SE 2)	*In one of my students' FYP (Final Year Project), he wants to be a pastor, but this is an Engineering FYP, so he has to do something related to Engineering. So I tried to make it something that he is motivated to do…in the end we agreed to look at the design of the church...how the church design is useful or not useful for the church goers and the evolution of the design over 10 years.* (LE 4) *I'm one of the lecturers in Science who joined the Club A (university art performing association). When I act, I always visualise how those cells divide and reconstruct themselves. When I visualise it this way, I can immerse myself in that character.* (LS 3)

Transform (To synthesise features from two or solutions) S = 2 L = 2	*I have to do a programme for a project called micro house. The challenge is in the software part. It is really challenging when you have lights from Philipps, speaker from Google and water from elsewhere. You have so many different things from different brands, and they have their own proprietary protocol that you have to fuse them together…so I have to do a lot of search to understand different things and how they work, look at how people did it and how it can be applied to my solution. This is how I finally managed to design the whole smart system for the project.* (SE 4) *I was an intern in a biomedical company during a sem break. We had to create a publicity for a product. In my team the boss purposely bring in interns from marketing, and me from Science, and another two from technology and design. The cool stuff is the publicity product we made. I contributed to the Science part as in I know what the product is for and the effects. Then the design team actually come up with a model to show the product based on what I said, but it's not just a brochure, it's a touchable product for people to feel the effect, and the technology people will make it work. Then the marketing person tells how the publicity product must reach different people in different ways, so if it's email, how to comprise the lack of touching bit. It's so amazing. I'm so proud of the product in the end.* (SS 1)	*It's something that's based on what I remember – a teacher of mine long long time ago, what I see on TV – so it's a combination of those things. It's something I can't take credit for – a lot of these are pre-existing ideas that I have used and adapted in different ways.* (LS 2) *When I was involved in a thermal bag project for Pizza Hut..we integrate ideas, but just me of course, we actually do it in a team, and there are so many people involved, not just in engineering, but engineering itself there are many division of engineering knowledge that we need. So many people and lots of transdisciplinary knowledge – inter and intra engineering ideas are combined together. We even need people who do design to help this out.* (LE 1)
Create (To generate completely new solutions)	--	--
Others	--	--

Note. S=Students; L=Lecturers

The "Creative Strategies" column indicates the number of instances for each strategy identified in student and lecturer data.

When presented the participants with the taxonomic framework, all the participants generally asserted that they apply the creative strategies according to situations. Although *Imitate* and *Transfer* were mentioned more, the participants pointed out that there is no specific strategy that is commonly used or preferred. Their selection of strategies depended on the problems to be solved – whether the problem needed a simpler or more complex strategy to address. Therefore, there was no specific strategy that was perceived to be frequently or should be more frequently used. They did not highlight any strategies that were not incorporated in the framework. This point can be reflected in the quotes below:

> *I think it depends on the situation. I don't think I have a particular strategy that I stick to all the time. Maybe if I can Replicate, I'll Replicate. If I can't then I'll try other strategies.* (SS 2)
>
> *Depending on the situation, but I may, use the easier one first, if can't go with the more complex one.* (SA 1)
>
> *It depends. If I can use Replicate, why should I waste time and energy to Create? I will look at the feasibility and the cost effectiveness to decide on a strategy. It really depends.* (LA 1)
>
> *I'd say it depends on the problem. Easier problems may be solved by Replicate or Imitate, maybe Transfer too. But more complicated problems may need Transform or even Create. There is no fixed strategy should be more frequently used.* (LE 2)

The creative participants agreed with the survey participants that the order of the strategies is appropriately organised based on the level of creativity. However, they perceived that *Characterise* should be a pre-requisite to using all other strategies in the framework. *Characterise* was suggested to be removed as a strategy in the framework because it was perceived as a problem analysis process that is required along the problem-solving process, instead of a one-off phase occurring at the onset of the problem-solving process. The quotations below exemplify this view:

> *I think order is just nice, from low to high creativity, maybe Characterise is a bit strange because it looks like understand the problem, right?… but the most key problem is students don't understand the problem. They try to solve a problem they don't understand. I mean sometimes we are given a problem that I don't even know how to solve, I don't even know what the question is, then we can't even replicate because we don't know the problem. We don't know where to start from.* (SS 4)
>
> *I think the order everything is actually fine…I'm not very sure about Characterise. Let's say you want to find the velocity of a car you need to find acceleration first and then distance and then derive, so it's that structure ... Same example on how to increase market share in China, you can go through different steps. First you identify problem*

statement, second is maybe overview about China and then what are the problems and how you are going to tackle it. (SE 3)

Yeah I think the flow of the level of creativity is very appropriate, it allows people to see that oh, these are the different ways to be creative…I have music background. If we want to create musical or conduct a symphony, the first thing we do is actually Characterise the problem. We analyse the theme first, then decide which songs to be selected. In between there'll be lots of other issues, but we keep analysing them and keep solving them a long the way. Maybe it should be something like a process, not a strategy, it's hard to know where to place it. (LA 4)

If Characterise is an analysis, analysis is needed in every phase of problem solving. I used to work on a project that designed thermal bags for Pizza Hut. Before we even planned, we identified the problem first – what are we trying to solve here. We know food below 65 degree Celsius will start to have bacteria, and the bag must sustain the warm for at least 2 hours. So from there we start working on it. That's Characterise to me. But it won't end there because once we solve one problem, another problem will arise, so problems keep coming and we keep addressing until we finish the end product. You can remove it, but others are fine and clear, and the arrangement is logical to me, and it's good to give us an overview of what we can do be creative, and can select the less creative ones or the more creative ones, not necessarily to aim for Create. (LE 1)

7.5 Relevance of the Taxonomic Framework to Students and Lecturers

In this section, I discuss the relevance of the taxonomic framework as perceived by the nominated creative participants. The discussion is organised according to the two areas i.e., (i) the uses of the taxonomic framework and (ii) improvements for the taxonomic framework.

7.5.1 Uses of the Taxonomic Framework

The findings from the interview data show strong alignment to the survey findings. The general conclusion was that the framework could be used for *Teaching*, *Learning* and *Assessment*. However, the framework's flexibility was seen as a concern that may affect the feasibility of the framework in teaching, learning and assessment.

7.5.1.1 Teaching

Nine lecturers indicated that the framework could be used as a tool to develop creativity through *explicit creativity training programmes*, *nurturing creativity* and *planning for creative curriculum*. Most of them, seven out of nine, emphasised the use of the framework for teaching about creativity through explicit creativity training programmes. The lecturers appeared to stress on teaching the strategic knowledge about creativity. It could be understood that knowing about the strategies for creativity could help individuals to consciously exercise creativity, which reflects the metacognition of creativity.

> *I think it can be used as an intervention programme for new lecturers and lecturers who think that they want to be creative...<u>this can directly teach what is creativity and all the strategies here</u>.* (LA 4)

> *What I would probably use <u>is I could run a workshop for creative strategies</u>. Maybe, I'm not too sure…what I could imagine is to have examples for each strategy, like Replicate, so the examples…and then get them to do activities. So there could be a workshop like this <u>to help students pick up all these strategies, and for them to apply them</u>.* (LS 2)

> *There is a great potential for this framework to t<u>each students the strategies for creativity.</u> Just like TRIZ, a creative framework for engineering. So they know the possible matrix (for TRIZ) for creativity, and they can use it, but they need to know what is available first. I think your framework has the same function. Yours is not specific for engineering, so you can use it for other fields.* (LE 3)

Another two views on creativity were on nurturing creativity and planning for creative curriculum. Nurturing creativity, mentioned by one lecturer, refers to cultivating and developing creativity in individuals. These views can be seen in the quotes below:

> *I think I can even use this to teach my 3-year-old…starting to prep him to know the tips for creativity like, I can get him to copy first, then slowly get him to move higher.* (LS 2)

> *I can use the strategies to indirectly foster creativity. Let say if I'm teaching creative writing, I can sometimes ask students to replicate a poetic structure, sometimes maybe to imitate the structure, and integrate them sometimes. For example, how to combine the essence of Sonnet and Haiku.* (LA 2)

Planning for creative curriculum, highlighted by one lecturer, refers to incorporating the strategies into module planning across year groups.

> *I can use it to plan the module, and also to plan for my Year 1 to 3 modules. I may focus more on the lower strategies in Year 1 or at the beginning of the module, but focus more on the higher level strategies as their [the students] learning progresses.* (LE 1)

In general, the lecturers felt the necessity for using the framework and it appeared that its potential for use in teaching was not restricted to only the higher education context. Overall, the lecturers did not mention other uses that were apparently different from those in the survey.

7.5.1.2 Learning

When asked about using the framework for learning purposes, the framework was seen to be useful for *explaining creative endeavour* and *learning to be creative.* Eight lecturers agreed that the framework would be useful for explaining their own creative endeavour, and to understand their creative capacity in different areas.

> *I think I can use it to explain my own creativity, which helps me to learn about my creative ability. I think I know what I do more often. If I find myself doing Replicate more, then I may find out why, and then try to push myself to use other strategies.* (LA 1)
>
> *Maybe I can learn to explain myself about what I do. For example, people ask me why am I creative or why am I doing things differently, or how I actually come up with an idea they call creative. I got this question a lot, but I think I now can learn how to explain my own creativity*. (LS 4)

One lecturer (LA 4) was reflecting on her leadership position based on the strategies in the framework. It can be said that the creative strategies in the framework could be used in explaining creativity demonstrated in leadership. This view is shown in the quote below:

> *If it is just sort of like housekeeping, I'm happy to make a joke, when I was acting head of school I could do the general day-to-day work making sure that everything is done. It wasn't very creative in that sense but things were being done so I probably was Imitating and Replicating a lot, meaning following what had been done before and then making sure that things were done. So the school was in good shape; it didn't break down but at the same time it didn't advance either. And it's not really in my nature to be high-level administrator but if I had that high-level of creativity on how we can develop the school, how can we Transform it then I would have big vision, tools and know how to do all these other things. That's like a mundane aspect and then there is that powerful sort of like life changing, world changing kind of thing, field changing… Because people asked why I didn't want to be head of school, now I can finally explain. Actually I was good at housekeeping just knew how to make sure that day to day was going well but in terms of long term vision I didn't have that.* (LA 4)

Another two lecturers expressed that they could use the framework to learn to be creative in other domains such as the entrepreneurship. Their explanations again somewhat emphasised the strategic knowledge perspective. These views from the lecturers are shown below:

> *I think I can learn to be creative using the framework. We want to be creative, but I know not many people know exactly how to be creative. I think I'm quite creative but I'm not able to explain why I'm creative. I can try different way to be creative. I'm thinking…I can use it to learn about entrepreneurship. I can start from Replicating some business model before I mix and match different entrepreneurship spirits and business principles.* (LS 3)
>
> *I feel I will use it to do business. Business needs a lot of innovation because it needs to always be different from the others. Even if you open a café, how to make your café stand out? I've been wanting to do business actually. I think this may be helpful. I'd*

use it to learn how to be creative first, knowing the strategies to be creative first, then apply it for Business. For example, I can Transfer some of the Engineering principles to business. I know I want to do business but I don't know what kind of business I want to do yet. So this probably could help. (LE 1)

When it comes to the students, eight of them believed that the framework could help them gain non-academic skills, particularly the self-enrichment skills such as learning photography, cooking, and instruments. The following quotes present these positions:

I recently joined the Photography Society. I'm thinking I properly can use it [the framework] to learn the position and angle, like maybe Imitating a particular angle, or Transform it…like…mixing different positions and angles. Maybe I can try this. (SA 4)

I think it's more than for academic purposes. I foresee I can use it for extra-curricular activities or even daily activities like cooking. A simple chore like cooking, if the strategies are applied, I think it can make life even more interesting. (SS 4)

Learning instruments can apply the framework, or even music. I just imagine, I'm now learning violin. (SE 1)

Based on the lecturers and students' accounts, it was an optimistic result that the framework was perceived to be able to enhance creativity in a non-professional context for personal development or self-enrichment activities. It suggested the flexibility of the taxonomic framework for various purposes and disciplines.

7.5.1.3 Assessment

Nine out of 12 lecturers indicated that they would use the framework to assess student creativity. One of the lecturers also proposed to share the framework with the students for transparent assessment. The framework was seen as helpful to explain and distinguish student creativity. This finding again substantiated the potential of the framework in developing metacognition highlighted by the participants in the earlier point. It also reassured that the framework could be a foundation to be developed as a transparent tool for measuring creativity. The quotes presented below illustrate this view:

I think actually we can share this [the framework] with students, and tell them, look, this will be the criteria you'll be assessed on. So the <u>students can be made aware of what they'll be evaluated o</u>n, and then they'll try to use those strategies to complete their assignment. (LS 1)

This is a great framework to assess students' work. It tells me whether the students are Replicating or Transfering or Transforming. I haven't looked at student creativity like this so far. I think this is such <u>a great tool for me to tell them what they are doing.</u>

> *In a way next time they can tell whether they are just copying and how much they actually innovate.* (LA 2)
>
> *It's very difficult to assess student creativity, and we don't have a guide and we don't consciously look for that. However we do tell students that we want them to be creative for certain assignments. I think this is the kind of assessment we can use to assess student creativity. The important thing is this [the framework] helps me to differentiate their creativity. Otherwise I probably know which is more creative, but I can't explain why. Now this will guide me to explain to students. To help people to be creative, the least they need to know is what they are doing and what can be done to be more creative.* (LE 4)

In general, the uses of the taxonomic framework for teaching, learning and assessment were attributed to several strengths exhibited in the framework. These perceived strengths are (i) *sense of progression*, (ii) *clear content and presentation*, (iii) *sound theoretical foundation* and (iv) *acknowledgment of lower-level strategies*. First, in consistent with the survey findings, the participants (eight students and nine lecturers) endorsed the developmental structure of the framework (sense of progression) for its potential to scaffold the learning of creativity and develop a new strategy for creativity. The following quotes portray this view:

> *One of the things I like is…because the strategies have lower ones and higher ones, it can sort of help people to be creative slowly, there's a direction to go.* (SA 3)
>
> *If I know this [the framework] earlier, I think I'd know how to be creative better. Actually I'm just thinking of my painting journey. It really is like this. I learned by copying exactly, so it's Replicate, then it slowly becomes more free. I think it can guide people to the direction to be creative.* (SS 4)
>
> *The incremental organisation is very supportive of learning creativity, as I see it, because not everyone is creative. The creative one may not need this, but some students or even myself, let's say, need to and want to be creative, this can really tell what to do to be creative. There's a gradual path, although it's not a straight path, still we need something to guide us along the way.* (LA 1)
>
> *Some of our learning is incidental, and some is deliberate. I think the second one [deliberate learning] is important here, when we are talking about teaching people to be creative. I think it's like a blueprint. Some people may tend to use one strategy very often, but just can't breakthrough it. Let's say, if I use Imitate all the time and can't seem to stretch myself, with this, I know I can use Transfer, that may bridge my skill to reach Transform. This is what I can see for now.* (LE 4)

Second, the taxonomic framework was commended on its *comprehensible content and clear content presentation* by nine students and seven lecturers. The examples used were deemed appropriate and generally comprehended by most of the participants. It also indicated that the presentation of the content was appropriate and was able to facilitate understanding.

This strength was also recognised by the survey participants. This view was reflected in the quotes below:

> *I think the content is great. It's so comprehensive. I like you have the definitions, examples, and you also mention the impact of it. So it's very clear to me. I like the examples. They really help a lot.* (SA 3)
>
> *I like the way it is presented. It's not too worthy and it's like a graphic information. So it's easy for people to read it, and especially me, who is more visual. Though there are still lots of words, but the presentation of it really helps. I like the examples, they are very clear and explain the strategies well.* (SS 3)
>
> *I would have to say that it's extremely comprehensive. You mention the strategies, give examples and mention the outcomes and the impact. All these complementary details are helpful to understand this (the strategies) better. I think for me, the examples are nice, although I'm not from the Science background, but it's about cancer, so people tend to be able to relate to it. And you also have this "check yourself" here; although I'm not sure what it is for, but to me I feel it's more like a reminder of what needs to be done?* (LA 1)
>
> *The information and layout are pretty impressive. There are so much details going into this. I like the graphic organisation and it is easier for people to capture information that way. It's good that you're not just presenting the strategies and that's it. You also have other details to explain like the outcome and impact. So we can see how all these are related.* (LE 4)

However, the Checklist of the framework (represented in I-Can statements in Figure 5.5) was rarely mentioned by the participants and its function was unclear to them. This could be because of the lack of information and introduction that explained the functions of the different features in the framework.

Third, an important point to be highlighted is the comments from seven students that the framework *acknowledged the lower-level strategies* such as *Replicate* and *Imitate* in performing creative attempts. This means that all strategies were considered important as long as they help address the needs and solve problems. The acknowledgment of *Replicate* and *Imitate* as creative strategies could raise awareness of the range of creative acts that can be performed. The participants felt that this awareness could also help people to be more confident of their own creativity as one does not need to create a breakthrough to be considered creative. The quotations below reflect this perspective:

> *I think the framework is really good that it shows that copying (Replicate and Imitate) is not a bad thing. So it's okay for us to copy.* (SS 1)
>
> *I like it that it tells me I can Replicate and Imitate. All these while I thought they are not considered as something creative.* (SA 2)

I like all these strategies to be called creative strategies. If that's the case I feel that no one should be guilty of copying or just make slight changes to something. (SA 1)

To be frank, I never knew that Imitation is part of creativity. All these while if we duplicate things it's never considered creative; maybe even called a copycat. Now I feel that if we are looking at the perspective that we are finding ways to achieve a goal or something like that, then every single means is creative, although one could be more creative than the other. To me this is a great revelation, seems that I've been quite creative too. People should be told this. (SE 4)

Another strength of this framework was related to its resemblance in existing theories and taxonomies (*sound theoretical foundation*), as pointed out by two lecturers. As mentioned in Chapter Two, TRIZ is a framework for creative problem solving for engineering. Bloom's Taxonomy is a hierarchical model used to classify educational learning objectives into levels of complexity and specificity. The perceived similarity between TRIZ and this study's framework was their use for brainstorming purposes to facilitate divergent thinking. The perceived similarity between Bloom's Taxonomy and this framework was the systematic organisation of the strategies from lower level to higher level of complexity. This view is reflected in the quotes below:

The thinking behind it [the framework] is very similar to TRIZ. TRIZ is focused only to develop a product so for example I want this to happen so what should I do? Previously we don't have this. If I want something like, I want this room to be for certain temperature or something like that, before this we just brainstorm. There should be a way to avoid that because this can also end up nowhere. TRIZ will lead you more focused but it's very focused in engineering. (LE 3)

I think it's quite like the Bloom's taxonomy, where it organises things systematically. It is also from simple to complex skills. (LA 4)

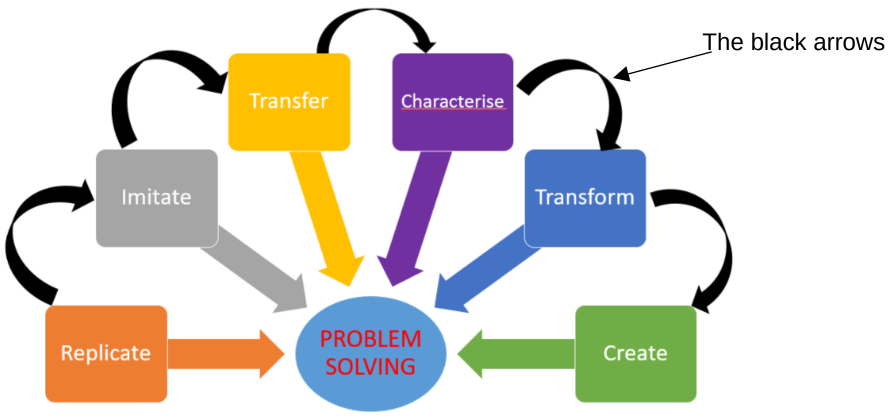
7.5.2 Concerns and Improvement for the Taxonomic Framework

There were several concerns about the framework shared by the participants. These concerns were (i) *misleading visual representation*, (ii) *examples and presentation of the framework*, (iii) *too many frameworks available*, (iii) *subtle differences between each strategy* and (iv) *flexibility of the framework*. I will discuss each concern, followed by the suggestions for enhancing the framework. The major concern that was expressed by the creative participants was the revised visual representation that was perceived to be confusing and misleading. Four students and two lecturers found that the revised visual representation i.e., semi-circular design, was confusing in three ways. Firstly, the black arrows (see Figure 7.1) in the visual representation were deemed to suggest a prescriptive developmental process for creativity. Although these arrows did not mean to allude to a series of prescriptive steps but to demonstrate the progressive complexity of the creative strategies from each other, it still created the same confusion as the pyramid layout. The quotation below explains why the arrows were seen misleading:

> *I think these arrows are misleading. To me I feel like it's a step-by-step thing. So we have to start from Replicate, then Imitate...then Create. But what if I start from Transfer and skip steps?* (SA 4)
>
> *If this is step-by-step, it think it's very not flexible, because I think no one has the same starting point and ending point. If it's not meant to be step-by-step, then I think the diagram is a bit confusing.* (SE 2)
>
> *These arrows (arrows pointing towards the term "problem solving"), I feel it's not step-by-step, but these arrows (Figure 7.1) suggest it's a step-by-step approach. Is that so?* (LA 1)
>
> *This is not a one-two-three-four-five-six procedure, right? Because these arrows (arrow A in Figure 7.1) seem to suggest that…if you say that it is there to suggest the increasing level of creativity, I don't think you really need that, it's only make it more confusing. Your definitions and common sense, I know the last one, Create, is most creative.* (LE 3)

Figure 7.1

Conceptual Design of the Taxonomic Framework for Creativity



Note. This is the revised visual representation after the survey phase. This revised version was shown to the participants in the interview. The black arrows in the visual representation indicate the progression and complexity of the creative strategies.

Secondly, the term "problem-solving" in the visual representation (see Figure 7.1 above) was perceived to be misinforming, according to two lecturers. Although the participants in the interviews closely associated creativity with problem solving, the term "problem-solving" depicted in Figure 7.1 and the term "creativity" were seen to be entirely different. One lecturer pointed out that illustrating problem solving as the core of creativity is inappropriate because not all tasks that require creativity are problems. The argument here perceived "problems" from a crisis perspective. In this study, "problem" was defined from a broader perspective to include gaps in knowledge understanding in various disciplinary areas. The quote below shows how the "problem-solving" term was perceived to be confusing:

> *Your document is about taxonomy of creativity? I don't agree with it because I think your premise is based on problem solving. Now that's a fundamental part, which I disagree. First of all there is a lot of things that there is no problem in there...problems are when you have a crisis to address… If you make a painting, write a novel, there is no problem, there is no solving anything but there is a lot of creativity there. You write a novel, you just come out of nowhere and there is no problem to solve and there is nothing to address if that novel exists or doesn't exist it doesn't matter to the world. You make a painting and I would say an art there is probably the largest demonstration of creativity but there is no problem there. So in order to, and this is nothing wrong with that just maybe the way put it, maybe if you really want to address that so maybe you say that that's the taxonomy of problem solving instead rather than taxonomy of creativity because creativity is a tool and I think it is more embracing than problem solving. Remember as I said earlier and I didn't say this particular like in art form I feel it is no problem, it does not address the need, it's not like okay we need to do something, there is a problem there and therefore we invent some conventional way of thinking.* (LE 2)

In spite of the concern of the term "problems" presented above, an account from a lecturer from the Arts and Science, who explained how she used "problems" in her lessons, showed how "problems" could be seen from a broader perspective. It shows that "problem" can be defined from various perspectives. As long as there is a goal that needs to be achieved that does not prescribe a clear operation and does not have an expected solution, that should be considered as a "problem" regardless of the disciplinary areas.

> *When I teach students to select a literary work to analyse or ask them to perform creative writing, I always ask them to find a problem – what do they want to find out? Or what is troubling them in the story being read? From there they have a purpose and can find inspirations there...there is no right or wrong answer in creative writing, and I can't predict what the outcome is in their writing, what they could come up with.* (LA 1)

In spite of the general appreciation for the content and the content presentation, three students and two lecturers mentioned concerns regarding the *examples and presentation* of the framework. First, they highlighted that the examples may be too discipline specific. Concurring with the survey findings, they suggested changing the medical-based examples to a more general one.

The examples can be changed to a more general topic, students not in the biomedical field may not easily understand the strategies…there were also terms that I needed to read twice, although it's very clear and I understand it. (SA 4)

The examples are too specific to medical-related field. Although many would understand, but to be more widely accepted, you could change it to something more general. (LS 4)

There was also a concern regarding the overall presentation of the framework, shared by three students and two lecturers. They suggested using visuals, colours, highlighting keywords and incorporating infographic to help users form quicker mental associations with key concepts related to the strategies.

You can add some visuals into this, like using icons or colours. This may help people to understand the strategies. (SS 4)

You should highlight the key words of the definitions. I think this helps people to catch the essence of each strategy. (LE 1)

The document has a few pages. Why don't you add one page that explains all the strategies in an infographic? Just one page, but you keep this [the detailed explanation of the framework]. People can quickly have an idea first before going deeper into the details. (LS 1)

Moreover, in spite of the positive indication that the framework was relatable to key principles of education and problem solving, three lecturers were concerned about *the many education-related frameworks that are available*, particularly Bloom's Taxonomy. They were concerned about the rationale of using this framework i.e., whether users would be convinced of the necessity and importance of employing this framework. Unless the framework could be easily integrated into other frameworks they are currently using, otherwise it is very likely that they would use only the framework prescribed in their departments.

There are so many products [frameworks and models] out there. We are asked to use different things. So can you convince me that I should use your framework? We use Bloom's. So do I use Bloom's and yours together? That becomes too troublesome. I think unless the person feels that there is a need, otherwise we use what we are told to use. (LS 1)

To be honest, you ask me if this is useful, I'd say yes. But will I use it or not? That's the question you need to ask. We are using so many frameworks, we must use Bloom's, that's one, then we also have another one that we use for Engineering. How would you make us use this on top of the other frameworks we are currently using? (LE 1)

One thing you must think about is how to integrate your framework to what other lecturers are using now. If you really want people to use it, make sure it's flexible to be infused in any framework. Lecturers are very practical people, we want something easy *to use, but there are too many frameworks we need to use.* (LE 3)

Furthermore, two students felt that the *difference between each creative strategy was subtle, making the strategies non-distinguishable*. This view is portrayed in the quotation below:

> *At first I can't really understand it, cause I think these things [creative strategies] do overlap with each other. These things are really similar, like there is this slightest difference between them. I thought they are all not related. So, for example, for Create, does it mean it involves other strategies?* (SA 3)

> *I'm not too sure if these strategies have lots of similarities, the difference may be too small to differentiate one from another. Would this cause a problem? Some may not be able to tell whether they are using Replicate or Imitate maybe.* (SS 4)

Lastly, the concern regarding the *framework's flexibility* was raised by two lecturers. This point would be relevant for the use of the framework for teaching, learning and assessment. The fundamental issue raised regarding the use of the framework comes from past experiences of expectations for strict compliance to any framework advocated by a particular department or institution. The quotes from the two lecturers below would be useful to understand this position:

> *… when I set exams I intentionally put a word "describe", and actually I want to write it a different way. I want to use determine but it is not on the list, I cannot find it on the list so I can't use it… I think people in engineering sometimes are very upset about such things because when we do things already it's embedded in the thing, when we ask the students to calculate or draw this already it's there if the person doesn't know anything then at least draw the diagram. So we are doing the same thing and suddenly you have somebody saying you have to write things in a certain way… maybe in the beginning he [Bloom] didn't intend it to be like that [restrictive]…if you can ensure this [imposed restriction] doesn't happen to your framework, then what you are going to do will be meaningful.* (LE 3)

> *I have this concern you know, sometimes when you have a framework, then everybody look at the framework kind of differently. Some people tend to be very rigid, it's like God sent you, and you have to follow everything. That's not the main point sometimes, it serves as a guideline. But once it becomes top down, then you have to stick with everything, then you become very destructive. So that's my concern…Otherwise it's a very useful guideline…I think understanding the true meaning of having this [the taxonomic framework] is important – what's the purpose of having this.* (LS 2)

7.6 Discussion

This section presents the discussion related to the research question this chapter attempts to address i.e., *what are the perceptions of the participant-nominated creative higher education lecturers and students on creativity and the relevance of the taxonomic framework for educational purposes?* Overall, findings revealed that creativity can be situated in the problem-solving context, and it is a skill that can be learned and taught. Additionally, the framework was perceived to be useful for the context of teaching, learning and assessment.

7.6.1 Definitions of Creativity

Findings from the interview revealed two perceptions of creativity that concurred with those demonstrated in the survey. First, creativity was conceptualised as a key necessity for problem solving. Secondly, creativity was associated with the ability to produce something unconventional (innovativeness) and original. Additionally, similar to the survey findings, the understanding of creativity is specific to context and person. Like the reference population in the survey, creative lecturers were perceived to be ones who employ different innovative approaches to teach effectively (teach with creativity). The following paragraphs discuss findings that are additional to those gained from the survey.

The interview findings provided an extended view about the problem-solving perspective of creativity. Creativity was seen as an important skill for solving real life problems that do not have existing procedures and solutions (solving ill-defined problems), and to generate multiple solutions when the existing solutions do not work (generating multiple solutions). Additionally, creativity in problem solving does not just involve applying existing knowledge, but also reconceptualising existing knowledge and resources to generate novel solutions (manipulating knowledge and resources). In spite of the predominant view towards creativity for real-world problem solving, the use of "problems" in actual classroom was believed to be ones that reflect well-defined problems, as students are always presented with problems after all information is taught and are expected to solve the problems using the taught procedures or information. The current approach to problem solving practised in higher education may develop a misleading impression that problems can be solved only in circumstances where all information needed for the solution is available. The underlying premise behind these findings may be that the higher education contexts seldom or often do not provide "real" opportunities to exercise and develop creativity. Drawing from these findings, in higher education, real-world, ill-defined problems should be prioritised. Additionally, these ill-defined problems should be used to challenge students' thinking and perspectives, and to teach them the strategies to think from different perspectives to produce multiple solutions.

In the context of teaching and learning, creativity was perceived as the ability to create impactful learning experiences. For a lecturer to be seen creative, they need to be able to make learning impactful for students, regardless of whether the learning is related to academic or non-academic matters. Findings revealed that the lecturers were largely aware of and mainly practiced teaching with creativity (teaching creatively). Only one lecturer practised teaching for creativity through providing students with agency in learning with an aim to allow students to express creaativity, which concurred with previous findings that examine creative practices in the classroom (Cremin et al., 2015; Cremin et al., 2006; Horng, 2005; Steele, 2016). Although previous research largely focuses on teaching for creativity (e.g., Dumas et al., 2016; Kamis et al., 2020; Shirazi et al., 2020), in actual classroom practice, teaching for creativity seems to be rarely practised but teaching with creativity, instead, have been widely practised. None of the lecturers mentioned teaching about creativity. This maybe because the lecturers' focus of creativity has always been on being innovative in teaching to improve students' academic performance. Another reason could be because of the lack of an explicit guidance in teaching and assessing creativity, even though creativity is advocated by the lecturers. This study also discovered a new finding i.e., creativity creates a sense of fulfilment that enhances wellbeing of the creators. The sense of satisfaction mainly comes from students' enjoyment in the class. Although there has been research (e.g., Orkibi & Ram-Vlasov, 2019; Tang et al., 2021) reporting meaningful relationship between creativity and wellbeing, the participants' association of creativity to sense of fulfilment or own wellbeing has rarely been reported in the literature in any depth. This finding implied that other than novelty and usefulness, which have been identified as important values of a creative output in the literature (e.g., Boden, 2004), another value of a creative output could encompass the sense of fulfilment.

Overall, findings on the creative participants' understanding of creativity supported the five propositions of creativity in this study. Echoing the survey findings, the understanding of creativity was more prominently associated with the Mental (the mental processes that invoke creativity) and Value propositions (the impact of the creative outputs bring). However, the creative participants in the interview provided a more variety and in-depth understanding of creativity within these two popular propositions. Additionally, similar to the survey findings, the participants did not see the relationship between all the five propositions i.e., Mental, Trait, Context, Outcome and Value. The way in which creativity was described was still rather atomistic, though the description of creativity and creative individuals was more in-depth and elaborated.

7.6.2 Relevance of the Strategies

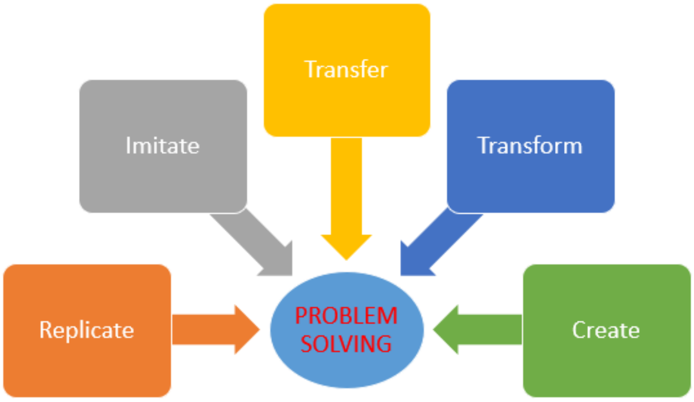
Like the survey, the order of the strategies (*Replicate*, *Imitate, Transfer, Transform* and *Create)* were well received. Similarly, there were a few concerns regarding Characterise as a strategy because *Characterise* was viewed to be a precursor to all other strategies. Taking into consideration the views of the reference population and creative participants as well as having reviewed the literature (e.g., Isaksen & Treffinger, 2004; Osborn, 1979; Schraw et al., 1995; Wallas, 1926), it is important not to view *Characterise* as a strategy in the framework, but a mandatory process at the beginning of any problem-solving initiative. As such, *Characterise* was removed from the framework as a distinctive strategy.

7.6.3 Relevance of the Taxonomic Framework

Echoing the survey findings, the framework was believed to be useful for teaching, learning and assessment. For teaching, the framework was perceived to be useful for explicit creativity training, nurturing creativity and curriculum planning. For learning, the framework was seen to be useful for explaining own creativity and learning to be creative. For assessment, the framework was appreciated for its potential in explaining student and own creativity. These uses were attributed to several factors including the developmental organisation of the strategies (sense of progression), having sound theoretical foundation and that the framework has clear content and presentation. Among these factors, echoing the survey findings, the developmental organisation of the strategies (sense of progression) was most appreciated. This further consolidated the view that creativity can be taught and learned. However, there were several concerns about the framework including the visual representation being misleading, there are too many frameworks available, the subtle differences between each strategy that makes the strategies lack distinguishability, and the concern regarding the framework's flexibility. The most apparent concern was the misleading visual representation caused by the unidirectional arrows in the visual representation, which caused the participants to assume that there was a prescribed step-by-step model in the framework. To address the perceived misleading visual representation, I removed the arrows in the semi-circular visual representation. The removal of the arrows was to suggest that the strategies should be exercised according to the situation, and the selection of strategies would be dependent on the problem solver's judgement of their appropriateness to the problem. The revised visual representation is presented in Figure 7.2.

Figure 7.2

Amended Conceptual Design of the Taxonomic Framework for Creativity

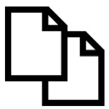
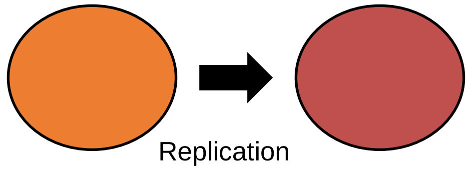
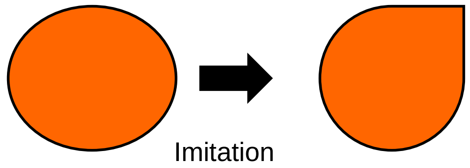
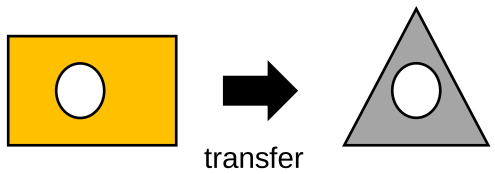


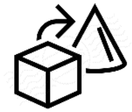
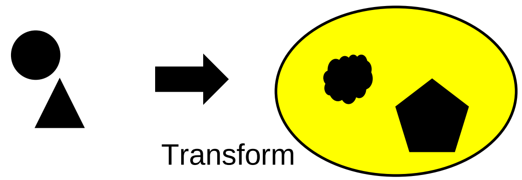
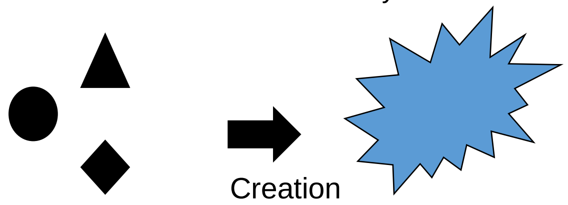
As a few participants raised concern regarding the medical-related examples that illustrate the strategies being too discipline-specific, to improve comprehensibility of the content, I changed the examples to ones that are generic, less technical and relatable to people from different fields or disciplines. Instead of using the cancer treatment examples, I changed them to ones that are related to the types of writing tools. These examples have been consulted with the coder and three lecturers from the Arts and Social Sciences, Science and Engineering faculties.

Additionally, the findings also indicated the need for an appealing and engaging format to present and communicate the content in the framework to make it user-friendly for lecturers and students. In response to the participants' suggestions, I incorporated visuals to enhance the explanation for each strategy. The visuals were inspired by Sternberg's (1999) use of visuals in explaining each type of creative contributions in his framework. Additionally, I also used a one-page infographic summary to incorporate the visuals and key words to capture the key ideas of each strategy. The decision to use an infographic is because infographic helps communicate complex information in an easily accessible manner (Toth, 2013). The role of infographic in enhancing learning has also been documented in previous studies (e.g., D'Auriol, 2016). The infographic summary of the strategies is presented in Table 7.4 below. The infographic contains the definitions of each strategy with highlighted keywords and visuals to explain the key concept of each strategy.

Table 7.4

Infographic Summary

Strategies	What is it?	Key Concepts	Example
Replicate 	To reproduce in the <u>identical image</u> of the existing product or solution to address an identical or similar problem or situation. The replication is by way of the: (i) adoption of an existing product or solution, or (ii) in parts, the form, idea and/or processes of the product or solution.	▪ If an idea/product/solution is replicated, the outcome will generally remain unchanged. 	**Problem:** Information or knowledge captured in wall painting cannot be transported. **Solution:** Paint/carve information or knowledge that is captured in wall painting onto a the slates so that the written pieces can be transported.
Imitate 	To <u>model after</u> an existing product or solution not in an identical manner to address a similar problem or situation The imitation may be an adaptation of: (i) the entire product or solution, or (ii) in parts, the form, idea and/or processes of the existing product or solution.	▪ If an idea/product/solution is replicated, the outcome will be slightly changed. 	**Problem:** ▪ The slates are too heavy to be transported. ▪ Very limited information can be captured in a slate. **Solution:** ▪ Putting information or knowledge on paper so that it is light to carry around and more information can be contained. ▪ Instead of painting, imitate the symbols to create words to communicate.
Transfer 	To develop a product or solution by <u>borrowing</u> from other resources of similar nature The transfer may be in the adaption of: (i) the entire existing product or solution from an unrelated field or (ii) in parts the form, idea and/or processes of the original from a related or unrelated field.	▪ When a product or solution is transferred, its function does not change when it is applied in a similar or different context. 	**Problem:** The information captured in a book/paper cannot be reached far. **Solution:** Mass production – printing and publication.

Transform 	To synthesise features from two or more products or solutions to develop an advanced product or solution to address a new problem or situation. The product or solution may be arrived at through the: (i) manipulation and (ii) reengineering of the form, idea and/or process of existing products or solutions.	▪ When a product or solution is transformed, its function changes when it is applied in a similar or different context. 	**Problem:** The information captured in a book/paper cannot be reached far. **Solution:** Using Word processor with Internet to share and communicate information or knowledge.
Create 	To hypothesise and generate completely anew, products or solutions. To synthesise diverse existing knowledge in unconventional ways to create new products or solutions. A completely new product or solution will be arrived at through the creation of the form, idea and/or process that is significantly different, relevant and more advanced from existing product or solutions.	▪ The process involved is unconventional. ▪ The outcome is revolutionary. 	**Problem:** The information stored in a hard drive may disappear. **Solution:** Using Cloud system to store, share and communicate information or knowledge.

Additionally, an important concern to be addressed was related to the flexibility of the taxonomic framework. Although this concern regarding flexibility was only raised by two lecturers, I deemed this important as this would affect the actual implementation of the framework. Therefore, stemming from this finding, it is important to provide a clear guidance on the goals of the framework and how the framework may be used. There was also a need to stress the flexibility that this framework allowed in accordance to needs, goals, contexts and users. This would be addressed after all the data had been collected from all the phases.

7.7 Conclusion

The interviews have helped me gain deeper insights into the beliefs about creativity, their creative practices and the perceptions of the framework from the lived creative students and lecturers, particularly from the position of teaching and learning. The findings provided critical information for me to assess and review the taxonomic framework from the perspectives of definition and scope of creativity, appropriateness of the creative strategies, relevance of the framework in terms of is uses, its flexibility, and the presentation of content of the framework. However, the interviews only allowed me to explore the perceptions of the participants without providing me with actual evidence of the function of the framework. First, it was unsure whether creativity can be facilitated using the taxonomic framework developed in this study. Second, there was no evidence that whether “problems” could really stimulate creativity. Third, the appropriateness of the decision of removing *Characterise* as a strategy was not justified. Therefore, I explored the actual functions of the taxonomic framework by getting students to engage in a problem-solving task, which will be discussed in the next chapter.

CHAPTER EIGHT

PHASE IV: Problem-Solving

8.1 Introduction

Studies investigating the development of creative thinking (e.g., Dumas et al., 2016; Shirazi et al., 2020; Ulger, 2018) have been largely focusing on creative outputs instead of the creative processes undertaken by the participants. These studies predominantly measured creative outputs based on fluency i.e., number of ideas produced and originality, but not the use of creative strategies to produce these outputs. Additionally, these studies did not examine creative processes from both the individual and group perspectives. While there are creativity frameworks that can be used to describe creative processes and outputs (e.g., Nilsson, 2011; Stahl, 1981), these frameworks have yet to be empirically examined, and are mainly based on a single dimension.

In the previous phases of this study, a taxonomic framework for creativity that aimed at developing creative behaviours in the higher education context had been constructed through a systematic extraction of features from existing theories, frameworks, taxonomies and research on creativity. The framework was further refined based on data collected from higher education students and lecturers via a survey and interviews. In this final phase of my study, I examined the use of this refined framework among a group of higher education students.

Using a problem-solving task, the study of this chapter aimed at exploring how the participants engaged in the creativity process when confronted with a real-life, ill-defined problem, with and without the taxonomic framework. Specifically, I investigated the thought processes involved in creative problem solving and if my taxonomic framework made a difference to the (i) range of creative strategies employed by the participants to solve problems, (ii) types of solutions produced and (iii) values of the solutions they developed. This phase is particularly crucial in finding out how the framework may work in actual practice. Findings obtained from the problem-solving exercise would address the fourth research question of this study, i.e., *how do higher education students engaged in creativity tasks display performance differences without and with the use of the taxonomic framework?*

8.2 Methodology

This phase employed a qualitative design i.e., protocol analysis, through the use of a problem-solving task, first without, and then with the support of the taxonomic framework. I used protocol analysis to explore and unravel the thinking processes that were involved in creative problem solving (Gilhooly et al., 2007), the way in which the strategies was employed and the quality of the solutions generated by the students. The protocol analysis involved data collection using the think aloud protocol, pair discussion and stimulated recall. This design of engaging the participants with the same problem twice follows the protocol of Dumas et al.'s (2016) study. This phase also explored the processes involved in individual and collaborative (pair) problem solving. To reduce the impact of task-effect during the participants' second attempt at the same problem, their thought processes while solving the task was explored using the think aloud protocol (individual task) and pair discussion (paired task). The section below presents the details about the participants, instruments, data collection process and data analysis of this phase of the study.

8.2.1 Demographic Details of the Participants

The participants involved in this phase were 12 third-year undergraduate students from the Arts and Social Sciences, Science and Engineering faculties. Four students were selected from each faculty. Experience and expertise have been perceived to be important in facilitating creativity in the literature (e.g., Amabile, 1982; Feldhusen, 2005) and by the creative participants during the interviews. Therefore, third-year undergraduate students were selected because they (a) were familiar with university-level skills and expectations, (b) had adequate exposure to higher education tasks and expectations, and (c) had sufficient subject area knowledge. Only third year students were included in this study to prevent differences in exposure, experience and expertise from influencing the participants' performance in the task. To investigate if the taxonomic framework was generally acceptable or if it lent itself more to any particular disciplines, the students were selected from all three faculties and different disciplinary areas. I also made sure that these students were not involved in either the survey or interview phases to ensure that they did not have prior knowledge about the framework. The students had to either complete the problem-solving task on their own (individually) or with a partner (pair).

Table 8.1 presents the demographic data of the students involved in the problem-solving task. The students were made up of a mixture of 50% Malaysian and 50% non-

Malaysian. Non-Malaysians include participants from Sri Lanka, United Kingdom, Vietnam, Iran and China.

Table 8.1

Demographic Data of the Third-Year Undergraduate Students

Individual/Pair	Participants	Faculty	School	Nationality
Individual	1	FASS	Media, Language and Culture	Malaysian
Individual	2	FASS	Applied Psychology	Malaysian
Pair	3	FASS	English	Sri Lanka
Pair	4	FASS	English	Malaysian
Individual	5	FOS	Psychology	United Kingdom
Individual	6	FOS	Biosciences	Vietnamese
Pair	7	FOS	Computer Science	Iranian
Pair	8	FOS	Computer Science	Iranian
Individual	9	FOE	Civil Engineering	China
Individual	10	FOE	Mechanical Engineering	Malaysian
Pair	11	FOE	Electrical & Electronic Engineering	Malaysian
Pair	12	FOE	Electrical & Electronic Engineering	Malaysian

Note. S=Student; L=Lecturer; FASS=Faculty of Arts and Social Sciences; FOS=Faculty of Science FOE=Faculty of Engineering

To invite students to take part in the problem-solving task, I sent an email to all third-year undergraduate students through each faculty. I explained the aim of this study and the objectives of the problem-solving task in the email. Once students' willingness to take part in the study was secured, I followed up with them by meeting them personally. I gave them more details of the study and told them about the estimated duration for the problem-solving session. I made sure that they were not involved in either the survey or interview phases to ensure credibility of the data. 24 students took part in the problem-solving task. Six students engaged in the problem-solving task individually, another six students engaged in the problem-solving task in pairs.

8.2.2 Data Collection and Research Instrument

The problem-solving exercise was conducted twice, first without the use of the framework and later with the support of the framework. This approach was used for two purposes, firstly to explore and understand how the students engaged in creative problem solving and secondly, to see if the use of the framework better facilitated the creative problem-solving process.

Students, individually and in pairs, completed the task either on their own, or with another student from the same faculty. Within each faculty, two students worked in pairs, and two students worked on the task individually. Each student or student pair completed the problem-solving task first without the framework, then they repeated the same task but with the framework. The decision of using the same task was based on the results of the pilot study (see section 8.2.3), which showed no difference in students' performance using the same task twice without the framework, but using two different tasks generated different responses due to differences of the problems and students' familiarity with the problems. I collected data from 18 accomplished tasks from the three disciplines (3 faculties x [2 individual tasks + 1 paired task] x 2 times).

The procedure for the problem-solving activity is illustrated in Figure 8.1. There were six steps involved in the full task execution.

Table 8.2

Execution of the Problem-Solving Task

Step	**Event**	**Details**
1	Explanation of the study and the task	I explained the aim of the study, the objectives of the problem-solving task, and what the students were required to do during the task.
2	Problem-solving task (without the framework)	The students were engaged in the problem-solving task without the support of the taxonomic framework. For students who did the task individually, they were asked to do a think-aloud protocol. They were given a trial practice prior to the actual task. The process of students engaging in the task was video recorded.
3	Stimulated recall	A stimulated recall interview was conducted with the students immediately after the task was completed. During the stimulated recall, the video was replayed to the students. The students and I were free to stop the video and commented on a particular event occurred during the task. The stimulated recall was video-recorded.
4	Introduction of the taxonomic framework	The taxonomic framework was introduced to the students. Students were allowed to ask questions until they understood the creative strategies captured in the framework. The briefing of the framework took about 30 to 45 minutes.
5	Problem-solving task (with the	Step 2 was repeated. However here, the students were doing the task with the support of the taxonomic framework.

	framework)	
6	Stimulated recall	Step 3 was repeated.

The instruments used in this phase were the (i) problem-solving task, (ii) think-aloud protocol, (iii) pair discussion, (iv) stimulated recall, and (iv) taxonomic framework for creativity.

8.2.2.1 Problem-solving task

The problem-solving task was used to explore how my framework could support problem solving in actual practice. Based on the understanding of literature (Garlick & Thompson, 1997; Neber & Neuhaus, 2012) and my interview findings, a simulated problem for creativity should reflect real-life problems that are ill-defined with incomplete information and unclear goals that embed more than just one problem and solution. Thus, the design of the problem-solving task adhered to the following features:

(i) it was based on a complex problem
(ii) it was open-ended for the use of multiple methods and strategies
(iii) it allowed for multiple solutions

The key consideration in designing this task was that the task would not have a single expected solution or route to solutions. This would allow the participants to solve the problems through different perspectives, strategies and solutions. I also made sure that the context of the task was a topic that students from all faculties could relate and could have views about it. Therefore, the context of the problem focused on higher education. The problem posed in the task was complex and multi-faceted so that it could be broken down into several problem components such as the roles and the goals of the higher education institution. This was to provide the participants with a focus to help them accomplish the task. The instructions of the actual task were as below:

> *The world is evolving at a tremendous pace spurred by advances in technology and innovation. In this context, education has to keep pace to ensure that students have to learn skills and competencies that are relevant for a sustainable future. These demands are necessitating education institutions to evolve and transform in multiple ways including in areas such as what they teach, how they teach and where they teach leading to continuous changes to:*
>
> - *roles of the institution*
> - *goals of the institution*

- *academic programmes and content taught*
- *the way teaching and learning happens, and*
- *how institutions are set up in terms of digital and physical infrastructure*

Imagine that you have been transported to the year 2080 – a future that is very different from the current reality.

In this context, what changes may take place (from your perspective as a student)?

The students were required to complete the same task first without the taxonomic framework, and later with the use of the taxonomic framework. They were given 20 minutes to complete the task.

8.2.2.2 Think aloud protocol

The think-aloud protocol was used only with students who did the problem-solving task individually. It was used to elicit direct verbalisation of cognitive processes when performing a task (Ericsson & Simon, 1980). This method has been used in insight tasks (Fleck & Weisberg, 2004), divergent thinking tasks (Gilhooly et al., 2007), convergent thinking tasks (Cranford & Moss, 2012) and real-world problem-solving tasks (Newell & Simon, 1972; Kozbelt et al., 2015). In this study, my objective was to elicit the thought processes and strategies the students employed during the problem-solving task. The process of the think aloud protocol is illustrated below:

- Step 1: explanation to students on how to think aloud during the task
- Step 2: trial run before the actual task
- Step 3: actual task (with think-aloud protocol)

To give students sufficient opportunities to perform warm-up trials and ask questions before the actual data collection (Ericsson & Oliver, 1988), I made sure that the students were trained to do the think-aloud protocol before the actual data collection. Prior to the actual data collection day, two trial sessions were run with each student. To minimise fatigue, each trial session was about 15 minutes. During the actual data collection, they were given another trial run before the actual task. The instructions and trial run of the think aloud protocol were adapted from Ericsson and Simon's (1993) instructions:

In this activity I am interested in what you think about when you find solutions to the problem in the task. In order to do this, I am going to ask you to think aloud as you work on the problem you are given. What I mean by 'think aloud' is that I want you to tell me everything you are thinking from the time you first see the question until you reach a solution or I tell you to stop working on the problem. I would like you to talk aloud constantly from the time I present the problem until you are asked to stop. I don't want you to plan out what you say or try to explain to me what you are saying. Just act as if you are alone in the room speaking to yourself. It is most important that you keep talking. If you are silent for any long period of time, I will ask you to talk. Please try to speak as clearly as possible as I will be recording you as you speak. Do you understand what I want you to do?

We will start with a practice problem to get you used to thinking aloud. While thinking aloud, tell me how many windows there are in your house?'

If the students were found struggling with performing the think-aloud method during the trials, they were given other practices (divergent thinking tasks) to help them familiarise with the method. In this study, all students were able to perform the think-aloud protocol during the trials before and during the actual data collection day.

Although the think-aloud method was found to not affect fluency and generation of novel ideas in divergent thinking task performance (Ericsson & Simon, 1993; Fleck & Weisberg, 2004; Gilhooly et al., 2007), Schooler et al (1993) identified an overshadowing effect for insight problem solving, because the verbalisation of thoughts could interrupt the solution generation process, therefore affecting the individual to attain the right answers. In this study, the problem-solving task was based on a real-world problem that did not have a single set of expected or ideal procedures to the solutions. The study only intended to find out the strategies used in solving the problem, and whether the use of the taxonomic framework better facilitated the creative process, but not the accuracy of the solutions. Hence, the overshadowing effect was not a major concern in this study. The students were told to continually report what they were thinking, and not to interpret, censor and over explain during the process (Kozbelt et al., 2015). I did not deliberately ask the students to focus only on certain information to avoid affecting their thinking process. The think-aloud process was video-recorded.

8.2.2.3 Pair Discussion

The pair discussion was conducted for students who engaged in the problem solving with a partner. The students assigned to work in pairs were told to solve the problem with their partners. Their discussion during the problem-solving session was video recorded.

8.2.2.4 Stimulated Recall Interview

As it was not possible for the participants to report every single thought process in the think aloud process and pair discussion (Ericsson & Simon, 1993), to have a more complete picture about the thought processes undertaken in the task, a retrospective method is needed (Ericsson & Simon, 1993). Therefore, a stimulated recall interview was employed. The stimulated recall interview was used to access, examine and understand the participants' thinking processes through their reflections (Fox-Turnbull, 2009).

The procedure of conducting the stimulated recall is similar to that of any interviews, but with the use of pictures, video or audio recordings (Henderson & Tallman, 2006). In this study, the stimulated recall interview was conducted immediately after the problem-solving task was completed. The stimulated recall interview was conducted twice – one after the task was completed without the taxonomic framework; another after the task was completed with the support of the taxonomic framework. For students who did the task individually, the stimulated recall interview was done individually with them. For those who did the task in pairs, the interview was conducted with their respective pairs.

During the stimulated recall interviews, I replayed the recordings and reintroduced cues that were present during the task (Sime, 2006). I used these cues to prompt the students to explain their thinking and decision-making at a particular time (Mackey & Gass, 2005; Sime, 2006). This method helped me understand and identify the creative strategies they used to solve problems without and with the support of the taxonomic framework. It also helped me verify data obtained from the think-aloud protocol and pair discussions.

When conducting the stimulated recall interviews, I first did an opening interview with background questions, followed by open-ended prompts to elicit participants' reflection (Plaut, 2006). I did not have a fixed set of questions during the stimulated recall because the prompts were triggered by the events captured in the recording. To effectively conduct a stimulated recall, I did the following to avoid pitfalls related to participants' memory, retrieval and timing:

- providing clear instructions to each participant (Schepens et al., 2007)
- conducting stimulated recall as soon as possible after the problem-solving task (Mackey & Gass, 2005; Schepens et al., 2007). In this study, the stimulated recall interviews were conducted immediately after the task.
- stimulus should be as strong as possible (Mackey & Gass, 2005)

During the stimulated recall, I focused on the why and how-questions to provoke the students' rationalisation of their actions (King, 2002; Soter et al., 2008). For example, "why did you say this", "how did you come up with this solution?" were asked during the stimulated-recall interviews. Additionally, the students were also encouraged to pause and comment on any event when the video was played back to them.

8.2.2.5 Taxonomic Framework for Creativity

The taxonomic framework used during the problem-solving task was the version improved based on findings from the survey and interview phases. In this framework, there were five strategies i.e. (i) Replicate, (ii) Imitate, (iii) Transfer, (iv) Transform and (v) Create. The framework (see APPENDIX F) was accompanied with an infographic summary (Table 7.4 or APPENDIX G) to facilitate participants' understanding of each strategy. This framework, accompanied with the infographic summary, was given to the students when they engaged in the task for the second time.

8.2.3 Pilot Study

10% of the estimated sample size for my actual problem-solving phase was involved in a pilot study (Connelly, 2008). The pilot study for this phase involved eight students. It aimed at assessing my data collection protocol and the suitability of the problem-solving task. For the problem-solving task, the pilot study was important for two reasons. First, I needed to decide whether to use two different tasks or the same tasks for two problem-solving conditions (without and with the taxonomic framework). Secondly, I needed to decide whether to use different groups of students or the same students for both problem-solving conditions (without and with the taxonomic framework). In total, eight students were involved in the pilot study for the problem-solving task. These students worked on the task individually. The procedures involved were similar to the actual data collection process, where students were engaged in a think-aloud protocol when completing the task, and a stimulated recall was conducted immediately after the task.

I did three pilot studies for this phase to decide on the most appropriate design for this phase. These three pilot studies were (i) same students working on the same tasks twice without the framework, (ii) same students working on different tasks without and with the framework, and (iii) two groups of students working on the same task – one group with the framework, one group without the framework. The areas of investigation included the range of strategies being used, the number of solutions produced and the quality of the solutions i.e., novelty and usefulness.

8.2.3.1 Pilot study 1: same students working on the same tasks twice without the framework

In this pilot study, two students worked on the same task twice independently without the framework. This was to examine whether the repetition of the same task would affect students' performance. The task used with these students were the same task for actual data collection (see section 8.2.2.1 for task instructions). Findings showed that students did not demonstrate performance differences due to the repetition of the task. They repeated the same responses when engaging in the task for the second time. There were no additional responses when working on the task for the second time. In fact, they reached an impasse earlier than when they first approached the task.

8.2.3.2 Pilot study 2: same students working on different tasks without and with the framework

In this pilot study, two students independently worked on a task without the framework, followed by a different task with the framework. One of the tasks was the actual task (see section 8.2.2.1), another was Task B. The actual task required the participants to solve a problem related to the higher education context; Task B asked the participants to solve a problem related to the secondary school context. They were engaged in the tasks in a different order i.e., one solved the actual task first, followed by Task B, and vice-versa. Findings from this pilot study found that students' performance was influenced by their familiarity with the problems captured in two different tasks. From the stimulated recall interviews, the students indicated that their ideation process was more fluent when working on a task that they were more familiar with. Additionally, the two students indicated different levels of familiarity towards the two problems presented. This showed that students' familiarity with the topic or problem (higher education and secondary school) was individual specific, which made it a variable difficult to be controlled. The possible consequence of using two different tasks is that it would make it difficult to disambiguate whether any changes in the performances were because of their familiarity with the tasks and other individual factors, or because of the taxonomic framework.

8.2.3.3 Pilot study 3: two groups of students working on the same task – one group with the framework, one group without the framework.

Four students were involved in this pilot study. Two students independently engaged in the actual task without the framework. Another two students independently engaged in the actual task with the framework. One student who solved the task with the framework showed better performance in terms of the range of strategies employed, the number of solutions produced and the quality of the solutions. However, it did not allow me to ascertain whether the better performance in this student was due to the taxonomic framework or other individual factors such as familiarity with the problem, or the student has higher level of creativity. The other student who worked on the task with the framework did not show apparent performance difference compared to the other two students who worked on the task without the framework.

In Dumas et al.'s (2016), when examining the effectiveness of TRIZ approach in developing creativity, the same students worked on the same task twice, first without and then with TRIZ, and their solutions were compared before and after TRIZ was introduced. This consolidated that it would be more appropriate to use the same students and the same task for both conditions (without and with the framework). Through the pilot studies, some important considerations regarding the process of data collection were noted. First, I made sure the way in which I gave instructions to the participants was consistent across all students and pairs. Second, to ensure that the participants responded honestly throughout all phases, I continuously explained to them that confidentiality would be ensured, and their identity would be masked using pseudonyms. This aimed to reduce participant bias so much as possible.

8.2.4 Data Analysis

Data from the think aloud protocol, pair discussion and stimulated recall were analysed using a protocol analysis. The protocol analysis is a method to elicit cognitive behaviours and thought processes (Ericsson & Simon, 1993). In this phase, the protocol analysis was used to understand how the participants engaged in the creative problem solving and the way the framework might have influenced the way students approached the task.

8.2.4.1 Think-aloud Protocol, Pair Discussion and Stimulated Recall

Once I had transcribed the think-aloud protocols, the pair discussions and the stimulated recall, the transcriptions were divided into segments that made up one distinct idea for coding (Ericsson & Simon, 1993; Gilhooly & Green, 1996). These segments were divided based on the students' accounts of each solution. Each segment contained data on a strategy, the types of the solution produced and the values of the solution. I also noted the creative problem-solving process reflected in each segment. When a new strategy is mentioned, the previous segment ended and a new segment began. After the data was divided into segments, I first coded the problem-solving process, followed by the strategies, the types of solution and the values of the solutions. Data coding for this phase is explained below:

(i) the processes undertaken in creative problem solving

The processes undertaken in the creative problem solving were coded inductively.

(ii) if the taxonomic framework better supported creativity by looking at:

- the range of creative strategies employed

  I coded the strategies based on the five strategies on the taxonomic framework i.e., *Replicate, Imitate, Transfer, Transform, Create*
- the types of solutions produced by the students

  I coded the solutions as *concept, process or product*-based solutions*.* *Concept* is an abstract or concrete idea or a hypothesis, (ii) *process* is a set of methodologies or procedures to undertake or implement a concept, and (iii) *product* is a concrete outcome manifested from a concept and/or process.
- the values of the solutions produced

  I coded the values as “novel” and “useful” (Amabile, 1982; Boden, 2004). Novelty refers to the degree of newness in a solution, where the solution offered is new to the context of the problem. Usefulness refers to the appropriateness or functions of an output, where the solution is functional and ready to implement. Any other values that emerged from the data would be noted and incorporated.

Table 8.3 below presents an example to illustrate how coding was done in the protocol analysis for think aloud and pair discussion according to segments. In the table, the purple-coded phrase refers to the strategies employed; the green-coded phrase refers to the types of solution generated. I made sure that if strategies that did not reflect any of the five strategies were identified, they would be noted. Similarly, if there were other types of solutions that did not reflect the three types of solutions captured in the framework, they would be recorded.

Table 8.3

Process of Coding

Segments	**Processes Undertaken**	**Strategies Employed**	**Types of Solution**	**Values of the Solution**
Maybe there won’t be any faculties. Now we have Engineering, Arts and Science, but in future there’s no specific field anymore.				The solution was **not** novel i.e., not new to

Students can select their own modules. Now although I can take modules from School of English and Politic Relations, but it's still Arts and Social Sciences. Why can't I take a module from Engineering and Science? So I think teaching and learning should have a customised approach for students to choose their own subjects.	Idea generation	Imitate (Retrieving from experience)	Process	the context of the problem. The solution was useful i.e., functional and ready to implement. **This solution was not novel but was useful.*

To find out if the taxonomic framework facilitated creativity in the problem-solving process, I did a frequency count of each strategy employed and each type of solutions produced. This would help me examine if the range of strategies and the number of solutions indicated any difference before and after the taxonomic framework was introduced to the students. During the process of analysis, I also took note of important emerging findings.

8.2.4.2 Data Trustworthiness

To ensure credibility of data, I did a triangulation based on data collected from the think-aloud protocol / pair discussion and stimulated recall interviews. The data from multiple sources helped me to create a more in-depth picture of the process undertaken in creative problem solving, the strategies employed during the task, and the types of solutions as well as the value of the solutions generated during the task. The triangulation helped me examine if results from different data sources (think aloud protocol / pair discussion and stimulated recalls) inform each other on the areas of investigation of the problem-solving phase.

To ensure reliability in coding, eight transcriptions were given to an inter-reliability coder, who was a postgraduate student in Education, for coding. These eight transcriptions came from one individual task (think aloud protocol and stimulated recall interviews before and after the use of the framework) and one pair task (pair discussion and stimulated recall interviews before and after the use of the taxonomic framework). I explained to the coder the coding process delineated in section 8.2.4.1. The coder was also told to take note of emerging findings. The Cohen's Kappa test was used to determine the level of agreement in the codes derived by me and the coder. There was good level of agreement between our interpretation, k=.84.

8.3 Findings

The findings of this phase will be presented according to two conditions i.e., (i) problem-solving tasks without the support of the taxonomic framework and (ii) problem-solving tasks with the support of the taxonomic framework. For each of the above sections, the discussion will cover the following four areas:

(i) the process of creative problem solving – describing the processes taken in solving the problem. This helped in understanding how creativity takes place in problem solving.

(ii) the range of strategies – discussing the types of strategies used in solving problems. This helped to examine the role of the framework in facilitating the problem-solving process.

(iii) the types of the solutions – elaborating the types of solutions (*concept*, *process* and *product*) produced. This also helped to examine the role of the framework in facilitating the problem-solving process.

(iv) the value of the solutions – describing the values of the solutions in terms of novelty and usefulness. This helped to examine the role of the framework in generating solutions that are valuable.

Data from all participants from the three faculties and their academic disciplines are tabulated collectively as a group because there were minimal differences between findings from the students across faculties and disciplines. In the discussion, I will highlight the differences between findings from the individual and paired participants only when clear distinctions are available.

For each problem-solving activity, I used the following labels to indicate if it is an individual or a paired activity, and the disciplines the students were from:

- I refers to individual activity
- P refers to paired activity
- IA refers to individual task completed by students from Arts and Social Sciences
- IS refers to individual task completed by students from Science
- IE refers to individual task completed by students from Engineering
- PA refers to paired task completed by students from Arts and Social Sciences
- PS refers to paired task completed by students from Science
- PE refers to paired task students from Engineering

As there were two individual tasks from each faculty, every individual task was assigned a number. These labels will be used in the discussion of findings in the following sections.

8.3.1 Findings of the problem-solving task without the support of the taxonomic framework for creativity

When the students were engaged in the problem-solving task without the use of the taxonomic framework, findings revealed the following:

- When engaged in the problem-solving task, the first step undertaken were *Characterise. This was followed by Solution generation*.
- When generating solutions, the students proposed solutions based on their existing knowledge and experience – mainly relied on reproductive thinking.
- The use of strategies was unconscious instead of deliberate.
- The solutions produced by the students were largely *concepts* and *process.*
- There was a solution that was considered novel and useful but was not ethical.

8.3.1.1 Characterisation

All students started the task by *Characterising* the problem of the task. By *Characterising,* I mean analysing the problem and context, which included identifying the different components of the problem and gathering information about the problem. The students tried to explore and understand the problem given first before generating any solutions. For example, a student from the Arts and Social Sciences, *Characterised* one of the problem components in the task i.e., role of institution, by identifying the structure of the institution *(the university and then the lecturers)* and the roles the institution should play. The quote below reflects the students' *Characterisation*:

> *And the role of the institution I am thinking about the purpose of the people that are up there, the University and then the lecturers. They would probably want to utilise whatever resources that they have to make learning better.* – IA 1

Similarly, a paired students from the faculty of Science *Characterised* another problem component in the task i.e., the goals of the institution, by identifying the current demands in the market. The conversation below extracted from the pair discussion of two students from Science illustrates the process of *Characterisation*:

> *S1: What would be the goals of the institution?*
> *S2: How's the market like right now? What do they want? That should be the goals of*

any university anyway.
S1: Hmm…people are all talking about 21st century labour market … they all talking about people need to think on their own feet.
S2: Let's work on that and see. So the goal is to produce students to can think on their feet.

– PS

From the two given examples above, in order to decide on the future roles and goals of education, they tried to respectively clarify the organisational structure of a university (people made up the university) and the market demands. They then attempted to address the problem (establishing the role and goal of future institution).

8.3.1.2 The Range of Strategies Employed by the Students

After *Charaterterisating* the problems, the students moved to the solution generation process, where they started producing possible solutions. Table 8.4 presents the range of strategies students employed during the problem-solving task. It displays the number of times each strategy was used by the students during the problem-solving process. The findings demonstrated that the strategies adopted by the students in the task reflected the strategies proposed in the taxonomic framework, even though they had not been introduced to the taxonomic framework. The students predominantly used *Replicate* and *Imitate* to generate solutions. *Transform* and *Create, however,* were not employed throughout the problem-solving task.

Table 8.4

Range of Strategies Employed by Students Engaged in Individual and Paired Tasks

Task	Frequency of Each Strategy Being Used				
	Replicate	**Imitate**	**Transfer**	**Transform**	**Create**
Individual	22	14	-	-	-
Pair	13	19	2	-	-

When the students were involved in solving the problem, they largely reproduced existing ideas when generating solutions. For example, when forming the goal of a future institution, through the use of the *Replicate* strategy, a student from the Arts and Sciences recalled the concept of holistic education from a past module she took. The example is presented below:

The goal of education is to educate people to be holistic. I don't think there'll be any changes in the future. It will be the same.

– IA 2 **[Replicate]**

The use of *Replicate* can also be reflected in the example below demonstrated by two students working in pair. They used their knowledge about the existence of online university to propose that the future university would be one that adopts a fully online delivery model:

S1: There'll be an online university.
S2: But even now we have online courses right. This is about 2080, it's like after 80 years.
S1: No I don't mean online courses, I mean all the courses fully online. My cousin told me there's already a full online university in Canada. I think in future all unis will be like that.

– PA **[Replicate]**

Apart from reproducing existing ideas, the students also frequently reproduced existing education practices and made slight modifications to the ideas i.e., the *Imitate* strategy. Their imitations were derived from their knowledge and experience in higher education. For instance, a student from Arts and Social Sciences who worked on the task individually referred to a current practice, which allows them to choose subjects offered by other disciplines within the same faculties. Based on this current practice, the student proposed that this approach should now be open across all disciplines offered by the university, not just confined to their own faculties. This instance of imitation is portrayed below:

Maybe there won't be any faculties. Now we have Engineering, Arts and Science, but in future maybe there's no specific field anymore. Students can just select their own modules. Now although I can take modules from School of English and Politic Relations, but it's still Arts and Social Sciences. Why can't I take a module from Engineering and Science? So I think teaching and learning should have a customised approach for students to choose their own subjects.

– IA 2 **[Imitation]**

In another instance, a student-pair from Engineering suggested the abolishment of exams in future teaching and learning processes. This solution was adapted from the idea of open book tests from their knowledge about open book exams for Law School students. This instance is reflected in the extract below:

S2: For teaching and learning, maybe there'll be no exam…I think even if there's an *exam, it should be open book tests. I don't understand why I should be memorising formulas, when I can just look for the formulas and apply them…I have a friend doing law, he told me they have open book exams, they also have their statute on the table.*

S1: So you mean in future there'll be open book exams only?

S2: No, I mean now there are already open book exams for some courses. Many years later, there should be no exams at all, because there should be no memorising.

– PE **[Imitation]**

Compared to the more commonly used *Replicate* and *Imitate* strategies, the *Transfer* strategy was only employed twice by students working in pairs. The first pair proposed a biochip to be used in the university to track attendance. Based on the stimulated recall interview, the biochip idea came from the idea of tracking people using biochips. In this case, the pair was transferring the idea from a policing and security domain to educational use. This solution was offered by students for the recoding of student attendance. They have taken the concept and practice from another domain and applied it to the context of the university of the future. Therefore, there is a change of purpose in the innovated biochip, though the function of tracking remains the same. Though this solution may be innovative, it may bring about problems related to ethics and privacy. However, this solution clearly reflects the *Transfer* strategy, which is illustrated in the extract below:

You know the App A (the app for attendance record)…people don't have to go to class to 'tick' attendance. We can just inform them (those who do not attend classes) that the lecturer has unlocked the class and they can just log into it and 'tick' their attendance…we can use biochip, like the US, there maybe a biochip injected into the body and it will be like a punch-in punch-out system. So your attendance will be marked only if you really go to class (attend the class physically).

– PS **[Transfer]**

The second pair suggested having invisible furniture in future universities. The idea was derived from the Sci Fi movie where invisible furniture was used as a stratagem or a scheme to outwit the character's opponents. The students borrowed this idea to apply it in an education context. In this instance, the purpose of the invisible furniture has changed from being a stratagem to solving the lack of physical space for furniture and lab equipment. The use of Transfer is reflected in the extract below:

S1: …future university… how institutions are set up in terms of digital and physical infrastructure …

S2: invisible furniture, maybe? Future unis will have all invisible furniture? Hmm…like *the Darkest Hour or what, or the invisible boy, I forgot, so everything can be invisible, and the alien can just click and furniture can be visible and invisible, when it's invisible it works like a stratagem…so all future unis can have all furniture that can be visible and invisible.*

S1: Great idea, I remember watching something where you can control visibility…so when you want to use it, it's visible; when you don't use it, it's invisible…we always have problems with no chairs, not enough equipment in the lab, and always say no space and all that. So if it can be invisible when not used, then got (have) space…so logistic problem is solved.

– PE **[Transfer]**

These findings indicated that while the task was successful in engaging students in active problem solving, it also revealed students' use of a narrow range of strategies to generate solutions. Students largely tended to adopt what they were familiar with (*Replicate)* or adapt what they knew (*Imitate*) to formulate problem-solving options. It can also be inferred that their use of strategies was unconscious instead of deliberate. To some extent, this indicated that the strategies incorporated in the framework reflected the creative scheme in real life practice.

8.3.1.3 Types of Solutions

The types of solutions refer to the kinds of solutions students generated i.e., *concept, process* and *product*. Although at this stage, the solutions offered were hypothetical, the level of details provided by the students were used to help me assess if their solutions carried merely conceptual ideas, or they contained certain features of a methodology (process) or are concrete products. Table 8.5 presents the number of solutions in the forms of *concepts*, *process* and *products* generated by the students. Solutions offered by the students were predominantly *concept* and *process*. There were a total of 33 concepts, 33 process but only four products. Only two of the three pairs of students generated product-based solutions.

Table 8.5

The Range of Solutions Created by Students in Individual and Paired Tasks

Task	**Types of Solutions**		
	Idea/Concept	**Process**	**Product**
Individual	19	17	-
Pair	14	16	4

The *concept*-based solutions are abstract ideas that can be converted into a process or product. For example, a student from Engineering suggested that the role of institution in the future should be one that incorporates personalisation in learning. There was no suggestion on how personalisation in learning can be operationalised in the description. This concept-based solution is shown below:

> *The role of institution will be…will be focusing on personalisation in our (the students) learning.*
>
> – IE 2 **[Concept]**

The "creator" concept proposed by a student-pair from the Arts and Social Sciences faculty is another example of concept-based solution. They proposed that the role of higher education institutions in the future will be to ensure all students become "creator". Similarly, how this concept can be materialised in practice was not explained. The example is shown below:

> *The role of institutions in the future will be to make students become 'creator', because…remember we attended a seminar and the speaker said in future people are gonna be creating their own job, they may not be working for company.*
>
> – PA **[Concept]**

The *process*-based solutions explain how a methodology or procedure, delineated as a series of actions helps to perform an operation. For example, a Science student proposed that future learning should focus on lecturer demonstration, experimentation and self-exploration. This process-based solution is reflected below:

> *For teaching and learning, lecturers would provide demonstration and let students explore themselves. It should focus on doing things, not just learning theories*…*it should be demo, do and explore, then again demo, do and explore…just let us experience it, but now it's all theories, less hands-on stuff.*
>
> – IS 2 **[Process]**

The extract below presents another example of a *process*-based solution. Here, the two students were attempting to propose a process for blending learning. Instead of a mere concept of blended learning, they proposed face-to-face model for lab sessions and an online model for non-lab sessions as the process to implement the approach.

> *S1: Now we are at "the way teaching and learning happens", what do you think? How it happens now and how will it happen in 2080?*

S2: Now it's all physical, lecture and tutorial…in future, maybe a combination (blended learning)?
S1: But even now some are also doing combination right?
S2: Yes but not all, like us, we are not doing it. I think in future they will all be doing a combination. Oh wait, like how? If we have lab it's quite difficult to do online.
S1: Ohh…if that's the case, when doing lab, we do physical, when we have workshop maybe it depends, if we need the lab, we do physical, but if not, then online.
S2: Eh that sounds fine. So lab is online, no lab is physical.

– PE **[Process]**

The *product*-based solutions reflected concrete products or services that are functional. A pair from the Science faculty proposed a hologram room where lecturers will be recorded without the need for a lecturer being present most of the time. This example is illustrated below:

There will be a hologram room. The lecturers do not have to be present all the time, and all sessions can be recorded automatically.

– PS **[Product]**

Another product-based solution can be seen in the suggestion by another Science student. This product proposed is a personal information manager web app i.e., Outlook, where the student proposed to have a one-system outlook that connects the various platforms used in the university.

The system we have right now is not user friendly. We have email using Outlook, then we have Moodle, and we have a university portal. All these we need to log in and log out, and all three systems are for different purposes. Why can't we have one system that connects everything, then we just log in once, and can pay, and check mail and can log into our modules. Just like how University A is, their system is much more connected than ours. We can do something like this.

– IS 1 **[Product]**

The findings revealed that each strategy used by the students resulted in a solution. The solutions – *concepts, processes*, or *products*, can be generated by any creative strategies, those requiring reproductive thinking and productive thinking.

8.3.1.4 Value of the Solutions

I identified two predetermined codes to understand the quality of the students' solutions, which are the novelty and usefulness of the solutions. Novelty refers to the degree of newness of a solution, where the solution offered is novel to the context of the problem. Usefulness refers to the appropriateness or functions of an output in relation to the problem posed, and the solution being ready to implement. Unexpectedly, the code “ethicality” emerged from my data. Ethicality denotes the quality of being moral, in accordance with the standards of right and wrong. The code “ethicality” emerged because there was a solution that was novel and useful but created issues regarding humanity and privacy. Therefore, the overall quality of the solutions was then appraised according to these three criteria.

In the condition where problem-solving was accomplished without the support of the taxonomic framework, no solution seemed to meet all these three criteria. The most novel amongst all, was a solution related to the use of the microchip to track student’s attendance to classes. In this solution, the microchip has never been used in education for attendance tracking purposes, thus it met the criterion of novelty. Additionally, this solution was functional and ready to implement, thus meeting the criterion of usefulness. However, this solution would create other possible problems related to ethics and privacy, therefore violating the principles of ethicality. Consequently, even if this solution was novel, functional, easy to implement and may address the issue related to attendance tracking, the implications related to ethics and privacy potentially caused by this solution would deem it unviable.

8.3.2 Findings of the Problem-Solving Activity Supported by the Taxonomic Framework for Creativity

When the students were engaged in the problem-solving task with the use of the taxonomic framework, findings revealed the following:

- When engaged in the problem-solving task, the first step undertaken was *Characterise.* This was followed by *Solution generation*. However, the process of *Characterisation was* focused on the analysis of the strategies, not the problem.
- When generating solutions, the students employed a wider range of strategies based on their existing knowledge and experience, as well as breaking the conventions of existing knowledge and solutions, than when problem-solving without the framework
- The use of strategies was deliberate, leading to more elaborations of their solutions.

- The solutions produced encompassed *concepts, process* and *products*. There was an increase in *products*.
- There were solutions that met all the three criteria i.e., novel, useful and ethical.

8.3.2.1 Characterisation

Similar to the condition when the students worked on the task without the framework, they began the task with *Characterisation*. However, unlike the previous condition where *Characterisation* was about analysing the problem components (e.g., the roles, goals of institution), when they solved the problem the second time with the framework, they *Characterised* the strategies presented to them. In fact, the students Characterised the strategies throughout the problem-solving process. *Characterising* the strategies occurred in parallel to the students' increase of solutions. Being able to analyse the strategy could help them deliberately use the strategies to continuously build one solution from another. The example below shows how a student from Engineering *Characterise* the strategies to address the aspect of teaching and learning in the future. The student analysed the strategy, then considered a problem that he and other students were currently facing (modules and delivery model not being helpful in preparing students for actual work), and finally used the strategies by drawing from own experiences and existing knowledge.

> *I think teaching and learning…Replicate…Imitate…okay. Like now we have intern (internship) only after all the modules, Imitate is change something, I think, because what we face is we feel the modules sometimes cannot help us when we work. So I think maybe can do like one semester on campus, then one semester internship, then next semester on campus, just alternate it…*
>
> *Transfer…why should I Transfer…okay, I think there is a problem with one sem (semester) on campus and one sem internship because what I learn here maybe I can't finish learning things from one place and I have to move… maybe like Tesla [an American electric vehicle and clean energy company] – they offered certificate, what they do is they partner with colleges. I think those colleges are not university, but in future universities can do the same…hmm…if this is already happening, means it's not Transfer right, then (it's) Imitate.*
>
> IE 1

A student-pair demonstrated their *Characterisation* of strategies in the extracts below. Similar to the example above, the students in this instance first analysed the strategy, then identified a problem they were facing (waste of water and the smell), and finally applied the strategies by integrating their past knowledge and experience. In this excerpt, it shows that the students moved to the next strategy when they faced an impasse.

S1: Let's try innovate the "green campus" idea we had earlier.
S2: Plants surrounding campus…
S1: Maybe we try to Imitate…
S2: Actually the UK one, it's the landscape like the greenery, the lake that make it "green".
S1: It's quite difficult to Imitate already, because…we shouldn't be changing it from whole landscape to only one space having that green landscape, then it becomes less green already. ***[charaterisation of Imitate]***
S2: Maybe try Transfer? Something not related to education.
S1: Go with Sci Fi la, your favourite.
S2: Haha…okay think of some Sci Fi movie. Oh, this is a bit disgusting you probably feel, what about urine recycler? Cause nowadays so much water being wasted. [characterisation of Transfer]
S1: OMG…you mean we drink urine?
S2: Well…in the movie yes because the alien has to survive in the post-apocalyptic world. If it's too disgusting…but we can use it for the plants? I think it's difficult to force people to drink other people's recycled urine yucks. ***[characterisation of Transfer]***
S1: Sounds interesting. There needs to be a drainage system, which can channel the recycled urine into the plants. Then it's a "green campus" that uses <u>recycled urine</u> to feed the plants, and also toilet flush.
S2: I think that's the treatment system to make sure no smell. Actually we can also have…hmm…what else? Kinda stuck.
S1: What's next? Transform…meaning combine ideas.
S2: Continue with the "green campus" then. What else to combine further?
S1: Green campus with recycled urine treatment system where plants are feed in a recycle manner. Combine something else from something else. I think one thing is to avoid having smell, then need to set timer for some ambi pur (an air freshener brand). ***[characterisation of Transform]***
S2: Okay, so that means the campus needs to install different air freshener system at different locations, then maybe each time the Trent clock building or whatever clock makes the sound, that's when the air freshener should work. Then it's kinda have a system. The system will set that the plants will be watered 5 hours once each day, and each other the air will be purified.
S1: Great. So that's Transform.

PA

These findings revealed that the *Characterisation* of strategies facilitated the students to generate multiple solutions. Although the framework did not prescribe a step-by-step model from *Replicate* through to *Create*, most students tended to attempt different strategies from *Replicate* through to the higher-level strategies.

8.3.2.2 The Range of Strategies Employed by the Students

When *Charaterterising* the strategies, the students went through the solution generation process to come up with possible solutions. Table 8.6 presents the range of strategies students employed during the problem-solving task with the support of the framework. It displays the number of times each strategy was used by the students when engaging with the task. With the support of the taxonomic framework, there was a wider use of strategies employed in the problem-solving task – all except for the *Create* strategy that was not used by the students. The total number of strategies used was 101 in total, an increase from 70 strategies employed when the taxonomic framework was not provided.

Table 8.6

Range of Strategies Employed by Students Engaged in Individual and Pair Tasks

Task	Frequency of Each Strategies Being Used				
	Replicate	Imitate	Transfer	Transform	Create
Individual	22	26	10	5	-
Pair	12	23	3	-	-

When the students were involved in solving the problem, they were still inclined towards reproducing existing ideas. In the example below, the internationalisation policy was replicated from the student's knowledge about internationalisation policy learned in one of the lectures. Without changing the idea, the student reproduced it for future higher education policy. The replication of this idea is presented below:

> *Replicate…what I know...In foundation we had a lecture on internationalisation policy in education, and how this policy and the government plan is interrelated. So I can Replicate this. In future the globalisation trend will expand at a greater scale. I feel in 2080, university will all rule out the internationalisation policy.*
>
> – IA 1 **[Replicate]**

Likewise, one of the pairs from the Arts and Social Sciences replicated the "green campus" concept based on their knowledge about the implementation of the same concept in another university. The use of *Replicate* strategy in proposing this solution is illustrated below:

> ***S1:*** *Let's try Replicate…things we know...*
> ***S2:*** *In future people will even more be particular about sustainability, because of climate change and all that. I think university will have this kind of "green campus" concept to help create a sustainable world. Actually in the UK campus they are already doing it. It's called the "Green Initiatives".*
>
> – *PA* **[Replicate]**

Findings revealed that the students primarily produced solutions based on *Imitation* of existing understanding of education and education facilities. For instance, a student from Engineering adapted a teacher education's goal about ensuring educators are technology literate. He imitated this idea by changing this goal to ensuring the society is IT-savvy for the role of higher education in the future. The use of *Imitate* in this instance is portrayed in the quote below:

> *I think it's [role of education] about making the society IT-savvy. I'm trying to Imitate here. I know…currently education is like making sure lecturers are IT-savvy. Again I try to copy this idea. Instead of making the lecturers IT-savvy, the education should making the whole society IT-savvy.* – IE 1 **[Imitate]**

Additionally, the extract from the stimulated recall below displays one of the solutions produced by another pair of students using the *Imitate* strategy. The students attempted to emulate the nap room concept implemented in a university to propose a Nap Time approach. This *Imitation* was done through taking the Nap Time Concept from a physical nap space to modify it to a fixed Nap Time for the university.

> *…Imitate…oh nap time…you know in University B they have this Nap Space for students to nap? I think in future lecturers should allow Nap Time for students…it's just so tired sometimes especially after lunch, so a nap can just reenergise us.*
>
> *The difference between this idea (the proposed Nap Time approach) and that idea (the nap room) is we change it to a stipulated thing. The Nap Space is a room for students to go and nap whenever they like, but when it's stipulated, maybe after lunch, like from 2pm to 2.30pm will be set as Nap Time. Nap Time is really good, even just a short one.*
>
> – PA **[Imitation]**

Although the *Transfer* strategy was not widely used as compared to *Replicate* and *Imitate*, the use of *Transfer* has increased when they were supported with the framework. One of the solutions created based on *Transfer* came from a student from the Science faculty. The student suggested smart glasses as a solution by borrowing an idea from a movie to apply to the education context. The way in which this solution was created is shown below:

> *Okay…so what can I Transfer…can I take something from the movie? I watched Kingsman (a movie) and there is this smart glasses, where you don't have to attend the meeting, you can be everywhere and people can still meet with each other…can talk to each other as if the person is next to you. I think in future students will have this smart glasses and do group study in different locations. So maybe I'm transferring from secret service (the movie is based on a secret service context) to education.*

– IS 2 **[Transfer]**

Another solution i.e., the dog patting activity, produced through the use of *Transfer* proposed by a student pair from the faculty of Science is demonstrated below. The students were transferring an idea they experienced for charity from the medical domain (mental health) to the education context.

> ***S1:*** *Maybe we can try Transfer or Transform…so what to combine?*
> ***S2:*** *just now (the first condition) we have the 'patting the pet' thing right? Can we put this in the Wellbeing (Wellbeing centre), coz now it's basically just talk to the counselors right?*
> ***S1:*** *Oh, maybe we can set up a pet mental health clinic, so if students have mental health issue, they can have therapies with pets.*
> ***S2:*** *Oh great, yay, so are we Transferring? We change the "patting dog" activity (a donation activity – donate and pat a dog) to a mental health thing.*

- PS **[Transfer]**

With the support of the taxonomic framework, solutions based on the *Transform* strategy emerged from the data, which did not appear before the framework was presented. For instance, an Engineering student synthesised different ideas (hologram, lectures and tutorials) to come up with a solution i.e., holographic lecturer. Based on the student's understanding, she recognised that lectures are usually focused on delivery of content and therefore can be done by the robots. The student also reckoned that tutorials are focused on individualised support and is more interactive. Based on these understandings, she drew the conclusion that tutorials require the contribution of a human lecturer to be effective and successful. The thinking that went into this solution was both insightful and practical. In addition, this student was able to think ahead about potential problems that may arise from her initial solution for effective teaching and learning. Therefore she proposed a contingency solution should the robot not be able to address students' questions during lectures. This contingency solution was that the holographic lecturer would have a function where it can be called by the robot to address students' questions during lectures. In this instance, the idea of a robot being the lecturer, the human lecturer being the assistant and the hologram concept made up the holographic lecturer is a good example that reflects combining various ideas, knowledge, and experiences to develop a creative solution.

> *…Transform is combining different things?...I talk about robot (robot assisting lecturers in the class) just now right; may be I can make it like the robot do the lectures, and lecturers do tutorials, because tutors need human interaction. That means there'll be no lectures from the lecturers – only robot delivers lectures, and lecturers do tutorials… It can also be like a hologram thing, like a 3D VR, you know the hologram in concerts? So if the robot, during lectures, it can't handle students' questions, it can nudge the*

lecturers, and the lecturers can appear in the form of hologram to answer questions. So I have one (robot assisting teachers), two (removal of lecturers from lecturing) and three (hologram) ideas in one. – IE 1 **[Transform]**

Another example of Transform exercised by a pair from the Arts and Social Sciences is presented below. The pair attempted *Transform* strategy by experimenting and integrating different features of existing solutions to improve the initial solution they proposed i.e., recorder that transcribes audio data to text. From a recorder, they integrated several features i.e., the physical book, the laptop, the scanner and the photocopy machine to create a "lapbook" that can print notes with rewritable papers that are environmentally friendly. In the process, they attempted *Transform* twice, first when they intended to improve the recorder, second when they intended to solve a problem pointed out by one of the students i.e., how a laptop made of steel can be converted into physical books made of papers. The use of *Transform* assisted them in deriving knowledge and solutions from various perspectives and synthesising them as an integrated solution.

S1: Transform…what's Transform…okay…it's basically integrating different ideas.
S2: What about…can we combine some of these (the initial solutions they suggested)?
S1: Actually we were saying about a recorder provided by the uni. The recorder can straight transcribe audio to words. But that's Imitate. Wanna fantasise this further?
S2: Can…so, I sometimes would prefer flipping on pages instead of reading everything in the laptop. Can we add the hard copy element to this?
S1: Like Kindle?
S2: No, make it a hard copy you can flip on.
S1: Meaning once it's transcribed, it can turn into a physical form?
S2: Yes. It works? Like a book. When we take lecture notes, we sometimes write it down, sometimes type it out and sometimes we record it. So whatever it is, all these can turn into a book when you want to read it like a book. When you want to work on a laptop, it can also work.
S1: But…hmm…how would the "thing" be like? Like a recorder or like a book now?
S2: Maybe a transformable "lapbook"? So it can work like a laptop but also can be turned into a "flippable" book.
S1: Okay, meaning it's a what…haha "lapbook" you call it, and it can work as a recorder, scanner, that's why if we write something down, it can scan, if we record, it can transcribe. And it can work as a laptop and a book we can flip on.
S2: Yes!!
S1: I doubt one thing. I feel the materials…the laptop is like steel and iron, book is papers. I don't know how it can turn into that.
S2: But in future anything can happen.
S1: But at least it has to be logical like it needs to work.
S2: Let's look at Transform again, we have already combined our ideas. Let's see if we can still bring it other things further.
S1: Maybe it can function like a photocopy machine. So yes that's a "lapbook", but instead of saying that it can turn into a laptop and a book just like that, maybe you can select the parts you want it read physically, then the "lapbook" can sort of like "print" the book.
S2: I like this idea! Then to promote green culture, the book can be inserted back in to the "lapbook" and then it is rewritable.

S1: Great!

– PA **[Transform]**

With the support of the framework, the participants attempted more complex strategies like *Transfer* and *Transform*. This may be attributed to the fact that the framework provided them with both guidance and direction to think beyond their conventional thought paradigm. An engineering student, IE 2, explained, "*This framework helps me to think what I can combine to produce something and can even combine completely different things together."* The framework seemed to provide a schema of strategies to help students generate solutions by drawing from existing knowledge and past experiences, i.e., what they know, what they have experienced, and what they observed.

8.3.2.3 Types of the Solutions

Table 8.7 presents the types of solutions created by the students. It tabulates the number of each type of solutions produced i.e., *concepts*, *process* and *products*. By having the taxonomic framework as a guide, the total solutions generated by all students increased from 70 to 101. The most apparent increase was in the number of product-based solutions. From just four without the framework, there were 21 product-based solutions generated when the students were supported with the framework. Findings revealed that the new solutions were particularly apparent in the *process* and *product*-based solution categories, although the *concept* and *process*-based solutions recorded highest in number.

Table 8.7

The Range of Solutions Created by Students in Individual and Paired Tasks

Task	**Types of Solutions**		
	Idea/Concept	**Process**	**Product**
Individual	24	25	14
Pair	14	17	7

Similar to the results when problem-solving was done without the framework, the *concept*-based solutions were produced by students who proposed an abstract idea. For example, a student from Science suggested that the role of institution in the future would be to create a maker culture, which was a concept adopted from the maker culture implemented in existing schools. This concept-based solution is shown below. The student did not explain further on how the make culture concept could be operationalised in higher education.

Role of institution…I can Imitate…I think it will be more like the university will create a *maker culture. I know that this maker culture is done in the US schools – every child will be given materials to create new stuff. So in future I think universities will be something like this.* – IS 2 **[Concept]**

Another example of a concept-based solution was produced by a pair from Science. The students tried to imitate the idea of homeschooling concept. They imitated the concept by changing it from parents teaching the students to students learning together in a group. However, the students did not further develop the concept – such as how the curriculum should be like and how should teaching and learning happen. It is an abstract concept where the methodology to exercise this concept has yet to be thought about.

S1: We try Imitate. I really believe in future, everyone will be having this homeschool concept including the university.
S2: Oh like Jean and Sam. Actually my cousin is also home-schooled.
S1: Yes but they are kids. So we Imitate it, so it will be a homeschool university, not the one right now that's only for primary and secondary students.
S2: Yes, parents can't teach the kids when they are in uni, content is too difficult. So parents can't homeschool uni students…maybe in groups, students will learn together in groups.

– PS **[Concept]**

The *process*-based solutions produced by students who showed how a methodology or procedure delineates a series of actions to perform an operation. In the example below, a student from Engineering was modelling after the teaching hospital approach in a university. Based on the methodology used in the teaching hospital, the student proposed one to be adopted by future universities for all programmes offered in the universities.

…Imitate…I always like it like University A, they have a hospital for medical students to do their practice and housemanship. In future, all universities should have an industry attached to the uni for students to do their internship. It should be for each course. In University A, the students start going to the hospital since Year 1. It's part of the lesson. Every week they go, learn the basic surgical instruments then back to class. So they know how those tools look like since the beginning. And then when they move to Year 2, Year 3, they observed other things related to their content…Err…so something like that. In future, like education students will do internship in a school that's attached to the university. But not just internship, but since Year 1 itself. I'm Engineering student. So Year 1 itself I can go to the teaching company and learn the design first, visit dams for example, at least we know how a dam looks like. And later in Year 2 and 3 we can start trying out prototype, visit sites to involve in building tunnels, dam…so something like that.

– IE 2 **[Process]**

Another example of the *process*-based solution is shown in the example below, produced by a pair from the Arts and Social Sciences. Based on the students' experience of a tri-campus session in a branch university campus, they suggested that future universities should adapt an interconnectedness approach that provide opportunities for learning from other different universities across the globe. They detailed the processes that could involve in this approach. The excerpt that explains the process-based solution taken from the stimulated review with the pair is shown below:

> *We once had a lecture where we connected all the three campuses (UK, Malaysia and China), we can ask questions, and then we (all three campuses) can access the modules on Moodle for that class…I think in future there'll be more this kind of interconnectedness among universities, it won't be just own university like Nottingham, but it can be Imitated like among different universities like Nottingham, Cambridge and maybe another uni in Japan…the system should be a system for different universities to access modules offered by other universities. The steps would be, first log in to the system, select modules and the system could let you know if you have double-booked yourself for other classes. Then you can select any modules you like and join the classes together with other branches, and students from all other branches can join...and anyway, charges can be imposed and perhaps it could be a system registered by certain unis and students from these unis can have access.*
>
> – *PA* **[Process]**

The *product*-based solutions reflected the concrete products that are functional. A student proposed a product called the Bluetooth coffee maker where coffee can be brewed using a phone. In the stimulated recall, the students revealed that product i.e., Bluetooth coffee maker was replicated based on what she knew existing currently in the market, and all universities should equip with a Bluetooth coffee maker.

> *…actually the Bluetooth coffee maker is something I saw somewhere before. I saw that we can Replicate, so I thought of that. It's basically a coffee maker and we brew coffee using our phone. Quite cool. I think that can be a must-have infrastructure in future universities.*
>
> – IA 1 **[Product]**

Another *product*-based solution can be indicated in example provided by a pair from Engineering. In the simulated recall, they explained that there would be a Virtual Reality (VR) lab in future, where all teaching will be conducted in the lab. The VR lab solution was proposed to solve problem of the lack of exposure for experiencing and experimenting with actual tools related to their discipline.

Like pilot training school, they are using VR [virtual reality] simulation in their classes – all done in the VR lab… There will be VR labs in the university. Teaching will all be done in the lab. We'll know how exactly each hardware is like in reality...Now usually when the lecturer shows us a model, it looks maybe this small, but when we look at the real one at work maybe, it's actually much bigger. So I think in future this VR lab will be there.

– PE **[Product]**

An interesting finding was that while there was an apparent increase in the number of solutions produced by the individual students, the same increase was not observed in the data from students working in pairs. The data revealed that students working in pairs engaged in discussions of the strategies that the individual students could not do so. The discussion involved challenging each other and building upon each other's ideas to ensure the solution generated was something useful and workable. Although the process of challenging each other and co-constructing ideas is valuable in a collaborative problem-solving setting, it reduced the number of solutions produced as students solving the problems in-pairs may not have enough time to finalise their solutions compared to students working individually.

S1: Replicate…Sustainability is the hit thing now.
S2: So…you mean the role of the university in 2080 would be promoting sustainability. Now only at the advocate stage, but not much things are done, but it exists, it's a goal for most universities nowadays.
S1: Okay role would be to promote sustainability. Then the goal would be to become green university. Replication too, coz green university is everywhere.
S2: Let's look at facilities, if future uni's goal is to become green uni, what kind of facilities should there be?
S1: I know some people actually teach under the tree – usually for kids.
S2: Great idea. Maybe we try Imitate that?
S1: What about building something around the tree so that university students can at least appreciate the tree?
S2: You mean to teach under the tree too?
S1: Yes it can be. But how should that be, and why need something if we can just teach without building anything around the tree. It's more natural that way.
S2: but we need the board and anything like that, so there needs to be something right?
S1: Then the trees will be all covered up and how to appreciate the trees? I think if it's for teaching, then no need to build anything. When the lecturers teach under the tree they won't need those tools. if I were the lecturer, I don't think I need that.
S2: Alright. What about amphitheater? Like what we have now?
S1: That would be Replicate already, unless we make some changes.
S2: Okay, so the amphitheater can be used for teaching and learning, and for events like concerts. But we can make seats on top of the tree?
S1: Ahh okay. So even for teaching, students can also have seats on top of the tree if they want. Then are we abusing the tree?
S2: Nay…not really. I think if we wanna create appreciation, we can label the tree names and characteristics, then students learn more about the trees.

S1: Okay, that sounds like a workable idea.

– PE

Additionally, the data revealed that in some situations, students working in the pair felt the need to compromise with their partners and therefore were reluctant to champion a solution they derived. The dialogue from one of the pairs below reflects this situation:

S1: I think people will learn through downloadable data. So you don't have to learn. You just have to download data, and that data is your knowledge. Once it's downloaded, it's there. You don't have to learn. This is kind of from Deep Learning.
S2: I don't think so. I think this won't work.
S1: I think everything will be Virtual-Reality. This is what the pilot programme is doing.
S2: No not necessarily. If I can do it the normal way, why should I use Virtual Reality…May be we should agree to disagree?
S1: Okay fine. So what ideas you have?

- PS

The solutions suggested in the discussion above could have been developed into tangible solutions through the use of different strategies. However as one of the partners did not show agreement, the proposal was dropped.

8.3.2.4 Value of the Solutions

In the second problem solving condition i.e., with the support of the framework, there were instances of solutions that may met all the three criteria i.e., novel, useful and ethical. These solutions (i) were novel to the context of the problem, (ii) were functional and easy to implement, and (iii) did not impose ethical implications.

With the framework, three out of 101 solutions met the three criteria stated above. These three solutions were (i) the smart glasses, (ii) the pet-based mental health clinic and (iii) the teacher-robot role inversion and holographic lecturer. Table 8.8 below presents the three solutions with reference to the three criteria. The judgment of these solutions was done against currently available or known educational systems and practices. It also took into account relevant ideas, systems and practices from fields outside the context of education. These three solutions have been presented in section 8.3.2.2.

Table 8.8

Values of the Solutions

Criteria / Solution	Novelty (Novel to the Context of the Problem)	Usefulness (Functional and Easy to Implement)	Ethicality (Did not Impose Ethical Implications)
Smart glasses	It has yet to be used in any education context.	The hologram concept in smart glasses has been applied in other fields. Therefore, it is functional and easy to implement.	It has yet to be reported that hologram creates problems in relation to health, ethics and data management.
Pet-based mental health clinic	It has yet to be implemented in any education context.	Functional and easy to implement.	It is unlikely to create significant ethical problems, as animals have been widely included in mental health therapies.
Holographic lecturer	It has been used in education contexts, but this solution offers a novel communication system between lecturers and AI.	The hologram concept has been applied in other fields. Therefore, it is functional and easy to implement.	It is unlikely to create other significant ethical problems, as holography has been implemented in different contexts including education.

The synthesis and integration of ideas drawn from different solutions resulting in students' solutions seemed to bring out novel contributions to the field of higher education. These findings suggested that the use of strategies of the taxonomic framework facilitated the students to produce solutions that meet the quality of novelty, usefulness and ethicality.

8.3.2.5 Elaboration

During the problem-solving task, the students attempting the problem for the second time with the taxonomic framework were able to elaborate on their solutions better than when they first approached the problem without the framework. Elaboration refers to the level of detail provided in describing a solution, be it in the form of a *concept*, *process* or *product*. It is the extension of ideas in response to a given stimulus – this stimulus can be a problem or an inspiration. It is “the richness of detail in the ideas one produces” (Baer, 1997, p. 22). It can produce chain-like thinking (Guilford, 1967) that facilitates an idea to be converted into a prototype (Atlan & Tan, 2020).

Findings showed that the *product*-based solutions generated by the students after using the framework were more elaborated than those produced before they used the framework. The elaboration of the solutions is reflected in the quotes below. These quotes were also presented in section 8.3.2.1 to demonstrate how the students *Characterise* creative strategies. In the first example demonstrated by a student from Arts and Social Sciences, the student first suggested a hologram that contained one detail i.e., a touchscreen feature. After that, through the use of *Transfer*, other details i.e., the Kahoot feature, the log in and log out feature, the Q&A feature, the rearranging sentences feature and the maintenance feature were added to the touch screen hologram solution. The use of *Transform* further developed the solution to include a compact sized robot acted as a robot teaching assistant and the feature to pull out the drawer and ask for help.

> *Okay…so for Imitate, I will take from Sci Fi [Science Fiction]. There will be holograms, <u>like a touch screen slideshow</u>.* **[Imitate]**
>
> *…maybe if I try Transfer…so it's from another field…I can add <u>Kahoot features</u> into the hologram, like we can <u>log in and log out, answer questions, and we can also rearrange sentences in that hologram</u>…for <u>maintenance, can get Siri to get technician to help, but this takes time</u>…* **[Transfer]**
>
> *Can I Transform…it's integrating….oh I can do a <u>robot teaching assistant</u>, because now assistants are humans, they have to learn, but the robot is there when something goes wrong you can call the person but the first person at the scene is the robot, and they are programmed for maintenance. So maybe there will be a compact sized robot where you can <u>just pull out of the drawer and ask for help</u>. Something that will do the function that the human is supposed to do but faster and immediately and that way you don't have to waste classroom time.* **[Transform]**
>
> – IA 2

Another instance of an elaboration could be seen in "green campus" produced by a pair. This instance shows how the deliberate use of strategies facilitated the production of solutions, from a *concept* to a *process*-based solution, by adding more details to the solution. At first it was a concept called "green campus" replicated from the students' knowledge of the green campus concept exercised in the UK campus, as presented in section 8.3.2.2. Through the use of *Transfer*, they borrowed an idea from a Sci Fi movie. From the idea of using recycled urine for drinking for survival purposes, they innovated it to change the purpose of the recycled urine from human survival to agricultural purposes. Here, the "green campus" has a detail – a green campus that employs a recycle urine system for plants. Through this, they proposed a process on how the recycled urine can be channeled to the plants around campus. They then attempted *Transform* to incorporate another feature i.e., the air freshener. They then delineated that the recycled urine system should water the plants five hours once each day, and every hour the air would be purified.

> *S1: Let's try innovate the "green campus" idea we had earlier.*
> *S2: Plants surrounding campus…*

S1: Maybe we try to Imitate…
S2: Actually the UK one, it's the landscape like the greenery, the lake that make it "green".
S1: It's quite difficult to Imitate already, because…we shouldn't be changing it from whole landscape to only one space having that green landscape, then it becomes less green already.
S2: Maybe try Transfer? Something not related to education.
S1: Go with Sci Fi la, your favourite.
S2: Haha…okay think of some Sci Fi movie. Oh, this is a bit disgusting you probably feel, what about <u>urine recycler</u>? Cz nowadays so much water being wasted.
S1: OMG…you mean we drink urine?
S2: Well…in the movie yes because the alien has to survive in the post-apocalyptic world. If it's too disgusting…but we can use it for the plants? I think it's difficult to force people to drink other people's recycled urine yucks.
S1: Sounds interesting. There needs to be a drainage system, which can channel the recycled urine into the plants. Then it's a "green campus" that uses <u>recycled urine to feed the plants, and also toilet flush.</u>
S2: I think that's the <u>treatment system</u> to make sure no smell. Actually we can also have…hmm…what else? Kinda stuck.
S1: What's next? Transform…meaning combine ideas.
S2: Continue with the "green campus" then. What else to combine further?
S1: <u>Green campus with recycled urine treatment system where plants are feed in a recycle manner.</u> Combine something else from something else I think one thing is to avoid having smell,, then need to set timer for some ambi pur (an air freshener brand).
S2: Okay, so that means the campus needs to install different air freshener system at different locations, then maybe each time the trent clock building or whatever clock makes the sound, that's when the air freshener should work. Then it's kinda have a system. The system will set that the plants will be watered 5 hours once each day, and each other the air will be purified.
S1: Great. So that's Transform.

Overall the findings showed that the use of strategies facilitated students to develop ideas or solutions that contained more details that helped envisage how the solution would work. It did not matter if eventually the solution worked out, the important point is that the students managed to concretise their solutions through the strategies.

8.3.3 Other Findings from the Problem-Solving Tasks

An important finding related to the Value proposition on this study's taxonomic framework emerged from the problem-solving task. On the taxonomic framework, the features of the Value proposition were organised in an ascending order, from a value that is narrowly relevant to the person, to one that is relevant to the broader immediate context, a community, a wider community, a professional community, and the broadest global context. These values were arranged in correspondence to the order of strategies from *Replicate* through to *Create*. However, findings from this phase of study showed that any strategy may produce solutions that contain a range of values. This can be demonstrated in some of the examples of solutions produced by the students. For instance, the green campus concept offered by one of the pairs was a concept replicated from the existing “Green Initiatives” concept. Through the use of the *Replicate* strategy, the solutions produced had a personal value and community value, not just a personal value as suggested by my framework. Another instance is the Nap Time approach. This solution was imitated from the idea of a nap room in another university. Based on the framework, this imitated idea would have a value that concerns the immediate context i.e., the peers and lecturers in the context. However, this solution may have an extended value that goes beyond the immediate context. Therefore, the value is not determined by the strategies. This called for a change in the conceptualisation of the Value proposition of my taxonomic framework.

8.4 Discussion

This section presents the discussion related to the research question this chapter attempts to address i.e., *how do higher education students engaged in creativity tasks display performance differences without and with the use of the taxonomic framework?* Overall, students engaged in creativity tasks displayed performance differences without and with the support of the taxonomic framework. I will also highlight unexpected and important findings that were significant to this study.

Findings revealed that without and with the support of the taxonomic framework, *Characterise* had been demonstrated to be a precursor to all other strategies. Without the taxonomic framework, the students *Characterised* the components of the problem; with the framework while solving the problem for the second time, the students *Characterised* the strategies. While the *Characterisation* of problem tended to happen on the onset of the problem solving, the *Characterisation* of strategies occurred throughout the creative problem-solving process. The students did not *Characterise* the problem when they solved the problem the second time may be because they had understood the problem when they worked on the task the first time. In the second problem-solving attempt, with the framework, they first *Characterised* the strategy, and then derived knowledge and experience to support the use of the strategy to generate appropriate solutions. The literature demonstrated that ability to analyse or define a problem or task leads to more appropriate and original solutions (Csikszentmihalyi & Getzels, 1988). In this study, as the students were *Characterising* the strategies, the taxonomic framework facilitated students to draw from their knowledge and experiences, as well as reconceptualise previous knowledge to generate solutions. Regardless of whether they *characterised* the problem or strategy, this finding supported the survey and interview participants' views that *Characterise* did not fit in the list of strategies, and took place before employing a particular strategy. The removal of *Characterise* from the taxonomic framework as a creative strategy was therefore justifiable based on the collective findings from the three analysis phases.

With the support of the taxonomic framework, the students employed a wider range of strategies. Although the pilot study showed that repeating the same task with the same participants did not affect students' performance, it is inappropriate to claim that this study had fully excluded the possibility that repeating the same task with the taxonomic framework could have resulted in a wider range of strategies and the increase in the number of solutions, than the first attempt without the taxonomic framework. However, with the framework, the students' *Characterisation* of strategies seemed to have direct effect on the use of the strategies. Without the framework, their use of strategies, mainly *Replication* and *Imitation,* was largely unconscious rather than deliberate and strategic. With the framework, students attempted different strategies from *Replicate* through to the higher-level strategies although the framework did intend to prescribe that they must adhere to a step-by-step use of the strategies (i.e., Replicate → Imitate → Transfer → Transform → Create). With the framework as a guide, the process of ideation became systematic and strategic. This finding showed that the strategies can be incorporated into the context of teaching and learning to raise awareness about creativity i.e., teaching about creativity (Beghetto, 2017) and develop creative thinking i.e., teaching for creativity (Beghetto, 2017; Jeffrey & Craft, 2004). Students can be taught about the reproductive and productive thinking involved in creativity, and how these types of thinking can be exercised through the use of these strategies. This would be able to raise awareness about the thinking process behind creativity, which may in turn have a positive influence on students' beliefs about creativity (Plucker & Dow, 2010). Additionally, training students to use these strategies could in turn develop and enhance creative behaviours (e.g., Dumas et al., 2016; Kamis et al., 2020).

With explicit knowledge of the strategies in the second problem-solving attempt, the students showed more frequent use of productive thinking i.e., breaking old conventions to generate novel solutions through the use of *Transfer* and *Transform*. With *Transfer*, the students were consciously borrowing ideas from other contexts non-related to the problem they were addressing i.e., education. When borrowing the ideas from another context, the student repurposed the original aim of the solution to suit the context of the problem they engaged in. This process therefore facilitated the use of productive thinking in the creative problem-solving process. Through the use of *Transform*, the students were prompted to synthesise features from two or more solutions to develop a more advanced solution. The integration of ideas was strategically drawn from the students' schema from knowledge, experience and observation. More importantly, when different features or solutions were integrated and synthesised, it prompted the need for students to rearrange the pattern of the solution. These two strategies supported the use of productive thinking by triggering flexibility in student thinking. In spite of the increase in the use of productive thinking, *Create* was never employed in the problem-solving process, both without and with the framework. There could be two possible reasons. Firstly, it could be due to time constraints in familiarising with the strategies and in accomplishing the task. In the second attempt, when presented with the taxonomic framework, the students tended to attempt the strategies from *Replicate* through to *Create.* As such, the time constraint may not have given students sufficient time to employ *Create*. Beghetto, (2017) advised that any creativity-enhancement intervention should be intensive enough for creativity to be developed. Most creativity-enhancement programmes that reported successful results were usually conducted within a duration of eight to 14 weeks (e.g., Henrikson et al., 2017; Ulger, 2018). Thus, a longer exposure to the framework may have yielded a different and more significant result. Secondly, it could be because the use of reproductive thinking is more common than the use of productive thinking in any creative problem solving. As demonstrated in the survey and interviews, Innovativeness i.e., novel but not entirely new has been consistently considered as being creative. Originality i.e., entire newness, although highly appreciated as a concept of creativity, was not prioritised when it comes to appraising individuals.

With the guide of the taxonomic framework, the students seemed to produce more solutions than the first attempt. However this may also be attributed to the fact that the students were approaching the problem the second time. Additionally, findings demonstrated the strategies induced solutions there were new to the context of the problem, functional and easy to implement, and ethical. The improvement demonstrated in the novelty of solutions was in consistent with the earlier findings (e.g., Dumas et al., 2016; Shirazi et al., 2020). Despite the fact that the strategies supported progression to productive thinking, it is important to recognise that the higher number of solutions were largely produced through activating students' reproductive thinking i.e., using existing knowledge and solutions to solve problems without reconceptualising them. Through the use of *Replicate* and *Imitate*, the students consciously derived ideas from their knowledge and existing solutions within the same context of the problem being addressed i.e., education. Although these strategies may not produce creative solutions, they would still be useful in addressing problems. More importantly, exercising reproductive thinking seemed to be a pre-requisite for more productive thinking, which could explain why most students started with *Replicate*, followed by subsequent strategies when solving the problem. It also concurred with Gilhooly et al.'s (2007) results that students tended to draw from their memories first when generating ideas, from the closer semantic network to the more remote ones. In the literature, scaffolding has been demonstrated to be essential to systematically foreground relevant knowledge and skills in a staged manner when necessary (e.g., Gajda et al., 2017; Gardiner, 2017). This means that in the context of teaching and learning creativity, students could first be taught the reproductive thinking and then gradually support them to proceed to exercising higher level of productive thinking.

Moreover, findings demonstrated that other than novelty and usefulness, ethicality was another important criterion for appraising the value of a creative outcome. Ethicality was a criterion that emerged from this finding. This was an important value as creativity was believed to be important to ensure moral goodness (Niu & Sternberg, 2002), which has been recognised as an important value since the ancient Eastern perspective of creativity. Concurring with the interview findings, inspiring virtue was also recognised as a role of creativity. This means that when appraising a creative output, other than novelty and usefulness, ethicality should be another crucial value to be simultaneously fulfilled. Findings from this phase also questioned my initial conceptualisation of the Value proposition. Initially, the framework assumed that the degree of value parallels the level of creativity embodied in the strategies, e.g., *Replicate* produces solutions that are only relevant to the creators themselves, while *Create* produces solutions that are relevant to the world. However, my findings did not demonstrate this linear 1:1 correspondence between strategy and value. This contrasted existing theories that the different levels of creative thinking leads to different degrees of significance of a solution (e.g., Cohen, 1989; Sternberg, 1999; Taylor, 1975). However, this contradiction may also be caused by a methodological limitation. The participants were not asked to specifically elaborate on the consequences and impacts of their solutions at each level – creator (themselves), immediate context (among their peers), or a larger community. If they were asked to provide more explanation, a clearer understanding between the strategies and value may emerge.

Apart from producing more solutions and wider range of strategies in the second problem solving attempt, the students described and presented their solutions with greater detail during when solving the problem with the framework. This finding corroborated with Atlan & Tan's (2020) study but opposed Shirazi et al.'s (2020) findings. In Atlan and Tan's (2020) study, students' solutions were more elaborated after the Design Thinking framework was introduced. They rationalised that the elaborated description was due to the students' strong academic performance and the competition in the task where the best solution would be selected. In this study, students' academic performance was not measured, thus I am not able to link the elaboration of solutions with students' academic performance. On the contrary, Shirazi et al (2020) did not find any improvement in the elaboration of their solutions. However, they used a likert-scale questionnaire to measure students' perceived improvement in their solutions after the intervention. The closed-ended questionnaire would not have allowed participants to explain their improvement. In this study, the more elaborated solutions after the introduction of the framework could be because the framework allowed students to take risks and think expansively by presenting strategies such as *Transfer, Transform* and *Create*. This sense of freedom to explore and express may have allowed students to elaborate their solutions without being concerned with finding the right solution.

Finally, the findings showed that engaging in creative problem solving while working in groups or teams pose challenges. In this study, students working in pairs demonstrated less willingness to take risks with the strategies because they had to negotiate the strategies with their partner. While this could mean that the students may be making better risk assessment in the problem-solving process, their performance in terms of the number of solutions generated after the introduction of the framework was not as positive as their counterparts working individually. If more time was given, the pairs would have had more opportunities to be familiar with each other and to build trust, which could help them to be more synchronised in their risk assessment. The literature demonstrates that collaborative creativity is enhanced through team members negotiating with each other through posing challenges (Kenny, 2014) and active listening (Rock, 2008) to learn from other and to mutually scaffold each other's ideas (Goodwin, 1995; Rojas-Drummond et al., 2008; Roschelle, 1992). These qualities were shown in the pairs, but the lack of familiarity may have resulted in social inhibitions, the challenges of achieving consensus, and the desire to complete the task as fast as possible (Rojas-Drummond et al., 2008). This should be acknowledged as a limitation of this study. This result also showed that the result of creativity may not necessarily be immediate in any collaborative settings. Therefore, creativity studies employing the social psychology approach needs to take this into consideration.

8.5 Conclusion

In conclusion, students engaged in creativity tasks displayed performance differences without and with the support of the taxonomic framework. *Characterisation* was found to be a precursor to all strategies, where *Characterising* problems occurred at the beginning of the problem solving, and *Characterising* strategies occurred throughout the problem-solving process. The taxonomic framework facilitated creativity by supporting students in employing a wider range of strategies, generating more solutions, producing solutions that met all criteria of novelty, usefulness and ethicality as well as expanding solutions with greater details.

Stemming from the improvement students demonstrated in exercising a wider range of strategies and the quality of solutions in terms of the number of solutions, novelty, usefulness, ethicality and elaboration of solutions, it has demonstrated that the creative process can be guided through the use of the taxonomic framework and can be triggered by the "problem" presented. This means that in the context of teaching and learning, the "problem" should first allow multiple solutions and should not have an expected route to solutions. The "problem" should reflect real-world problems where information given should be incomplete. Only then students would be challenged to exercise more creative thinking, as failure in problem solving has been shown to trigger the need for breaking conventions (Fleck & Weisberg, 2004; Weisberg & Suls, 1973). This has also been demonstrated in the finding when the students attempted the subsequent higher-level strategies each time they faced an impasse. In conclusion, when the "problem" is appropriate and an explicit guide like a taxonomic framework of this study are presented to students, creativity is a highly teachable and learnable skill.

In sum, this phase has examined the actual function of the taxonomic framework, with a strong focus placed on the perspectives of the Strategies (Mental), types of solutions (Outcome) and values of the solutions (Value proposition). The differences of performance shown in the individual and paired task also supported the Context proposition of this study. In spite of the limitation in methodology in terms of the duration of exposure to the framework, time constraint for students to work on the task, the overall findings supported that the taxonomic framework was able to facilitate creativity.

CHAPTER NINE

CONCLUSION

9.1 Introduction

This study aimed to develop a taxonomic framework for creativity that could be used as a guide to understand creativity and apply creative strategies to solve problems. The research was conducted in a higher education institution in Malaysia. Employing a multiphase, mixed-method design, I first developed the prototype taxonomic framework for creativity through a synthesis of literature. Then, I explored students and lecturers' notions of creativity and the relevance of the taxonomic framework to learning and teaching in higher education. The findings in this study drew information and insights from a sample of university students and lecturers, participant-nominated creative students and lecturers, and finally, through a creative problem-solving task undertaken by the students. In this conclusion chapter, I will firstly, present the summary of key findings for each research question of the study. Then, I will draw implications from the important findings of this study. Finally, the chapter will provide a discussion on the limitations of this research, which leads to the recommendations for future studies.

9.2 Key Findings of the Research

In this section I will provide key findings of the research based on the four research questions of this study. These research questions have been examined respectively in Chapter Five, Six, Seven and Eight.

9.2.1 What are the features that make up the prototype taxonomic framework for creativity through a synthesis of the literature?

Through a systematic synthesis of the literature, 24 creative features were extracted to develop a prototype taxonomic framework for creativity. These features were made up of five propositions i.e., Mental, Trait, Context, Outcome and Value, that formed the conceptualisation of creativity in this study. The Mental proposition posited that creativity is invoked by a series of cognitive, affective and metacognitive processes. The cognitive process refers to a set of strategies, *Replicate, Imitate, Transfer, Characterise, Transform* and *Create*, that defined various creative actions. The Strategies, ranged from the exercise of reproductive to productive thinking, served as the primary functional features of the taxonomic framework. These strategies can be supported by features related to intuition (intuitive ideation and intuitive evaluation) and metacognition or tacit knowledge (person knowledge, task knowledge, strategic knowledge). The Trait proposition posited that creativity can be stimulated and impeded by the individual's personality. It comprised features related to motivation, risk taking and open-mindedness. The Context proposition proposed that creativity can be supported and hindered by contextual conditions. It consisted of a feature i.e., resources. The Outcome proposition suggested that creativity can be manifested in various forms. These forms included a *concept, process* and/or *product*. The Value proposition theorised that a creativity outcome may contain a value, ranging from a personal value to a global value. The value of an outcome could be defined by its novelty and usefulness.

9.2.2 What are the perceptions of the reference population on creativity and the relevance of the taxonomic framework?

In terms of the definition of creativity, creativity was predominantly understood as something unconventional (Innovativeness) and entirely new (Originality), and the ability to problem solve (Problem solving). A minority of the participants believed that creativity is a result of an "aha" moment (Spontaneous). The understanding of creativity was specific to context and person. In the context of teaching and learning, creative students were associated with the ability to problem solve (Problem solving), think critically (Critical thinking) and to produce something unconventional (Innovativeness) that has a personal value to the creators themselves (Personal creativity). Creative lecturers on the other hand, were associated with the ability to employ various approaches to teaching (Divergent thinking), connect content to students' experience and real-life context (Making connection), engage students according to students' interest (Engaging students), produce and employ teaching approaches that are unconventional (Innovativeness) and enhance student understanding (Enhancing understanding), and contribute knowledge to their professional domain (Professional contribution). In general, the participants' definitions reflected all the five propositions of creativity (Mental, Trait, Context, Outcome, Value), with more popularity in the Mental and Value propositions. In the taxonomic framework of this study, equal importance was given to all propositions as the framework proposed an inter-relationship among all the five propositions – the actions for being creative (Strategies, Mental), factors supporting these actions (Mental, Trait, Context), the creative outcome of these actions (Outcome) and the significance that the creative outcome produces (Value). However, findings revealed that the participants did not view the different perspectives of creativity as an inter-connected relationship; instead, their views towards the different perspectives of creativity were rather atomistic.

In terms of the order of strategies, the participants largely agreed with the order of the six strategies (*Replicate, Imitate, Transfer, Characterise, Transform, Create*), except *Characterise,* which was seen to be of similar level of creativity as *Transfer* and *Transform*. The framework was deemed relevant for teaching, learning and assessment. The framework could be used for teaching by incorporating the strategies into curricula and raising awareness about creativity. For learning, the framework could be used as a guide for developing ideas for teaching and learning. For assessment, it could be employed to assess others and own creativity.

The taxonomic framework was generally well received in terms of its potentials in facilitating and developing creativity, its comprehensibility and user-friendliness. This positive result was found to be mostly attributed to the developmental organisation of the strategies (Sense of progression) which helps provide guidance for developing creativity (Scaffolds for creativity), comprehensive details, clear language and clear content presentation. However, there were several concerns about the taxonomic framework raised by a few participants. First, the framework was perceived to prescribe a fixed step-by-step model where creativity must begin from Replicate through to Create (Rigidity). Second, the framework was seen to be restricting as creativity was regarded as a result of the “aha” moment out of spontaneity (Spontaneous nature). Third, the framework was deemed to suggest that productive thinking is more important than reproductive thinking, which in turn implies that strategies like *Replicate* and *Imitate* are less important to strategies like *Transform* and *Create*. The perception that the framework undervalues the less complex strategies like *Replicate and Imitate* may lead educators and students to defy personal creativity, which is part of the journey to a more innovative creativity (Vygotsky, 1978). In response to these concerns, the visual representation of the framework was revised from a pyramid to a semi-circular design. The semi-circular design aimed to illustrate the equal value and significance of each strategy in any problem-solving situation. The revised design also indicated that any problems might be solved using any one of the strategies rather than having to follow a prescribed procedure.

9.2.3 What are the perceptions of the participant-nominated creative higher education lecturers and students on creativity and the relevance of the taxonomic framework for educational purposes?

With regard to the perceptions of creativity, concurring with the survey finidngs, creativity was understood as the ability to produce an outcome that are innovative and the ability to solve problems. Specifically, creativity is important to manage real life situations and problems that do not have an existing solution and to generate multiple solutions to a problem especially when an existing solution does not work. In problem solving, creativity involves not only applying existing knowledge, but also reconceptualising existing knowledge and resources to generate solutions (manipulate knowledge and resources). Although creativity was seen as important for solving real-life problems, the "problems" presented to the students in the classroom does not usually reflect real world problems i.e., problems that do not have complete information, do not expect a particular solution and allow for multiple solutions. Besides, creativity was regarded as a capacity that could be facilitated by experience and expertise. It is also a capacity that could inspire enthusiasm and meaningful impact to the community, as well as creates a sense of fulfilment to the creators for better wellbeing. In general, creativity was generally seen as a skill that is both inherited and learned through formal learning and experience.

When conceptualising creativity as a quality of an individual, creative lecturers were appreciated for their ability to teach creatively by using multiple innovative teaching approaches. More importantly, creative lecturers are ones who create impactful learning for students, teach for creativity and challenge students. Creative students were perceived as one who has wide knowledge and experience as well as the ability to materialise creative ideas so that these ideas have an actual functional value in reality. They were viewed as ones who are resourceful and open to new ideas experiences. Furthermore, students' creativity was often assessed based on their creativity demonstrated in their presentation, specifically in terms of their presentation style and layout, instead of focusing on the creativity of the solutions produced by the students.

With regard to the relevance of strategies, echoing the survey results, the order of strategies was perceived to be appropriate (*Replicate, Imitate, Transfer, Transform, Create)*. However, *Characterise* was suggested to be removed as it is a precursor to all other strategies. Therefore it was inappropriate to be considered as a distinctive strategy. In terms of the overall relevance of the framework, the framework was perceived to be useful for teaching, learning and assessment. The framework was appreciated for the developmental organisation of the strategies (a sense of progression), the comprehensible content and clear content presentation, the acknowledgment of lower-level strategies in creativity and the sound theoretical foundation that underpins the framework. Several concerns were raised during the interview. These concerns included the misleading visual presentation that led the framework to be perceived as being prescriptive i.e., imposing a step-by-step model without flexibility, the needs for changing the examples and improving the framework's layout, concerns regarding too many available education frameworks, the subtle differences between each strategy and the flexibility of the taxonomic framework.

In response to the participants' concerns, *Characterise* was removed as a strategy from the framework. Additionally, the examples were changed from the cancer treatment examples to ones that were related to writing tools. Moreover, a one-page infographic summary that incorporated visuals and highlighted keywords was incorporated to communicate complex information in an easily accessible manner.

9.2.4 How do higher education students engaged in creativity tasks display performance differences without and with the use of the taxonomic framework?

The problem-solving task phase involved four areas of investigation i.e., (i) the thought processes involved in creative problem solving, (ii) the range of creative strategies employed by the participants to solve problems, (iii) the types of solutions produced and (iv) the values of the solutions developed. With regard to the thought processes involved in creative problem solving, findings revealed that *Characterisation* occurred at the beginning of the problem-solving process both when students engaged in the task without and with the support of the taxonomic framework. Without the taxonomic framework, the students *Characterised* the problem first before generating solutions to the problem. With the framework while working on the task the second time, the focus of *Characerisation* was on the creative strategies instead of the problem. This could be because they have understood the problem presented in the task after first attempting the task without the framework. Upon *Characterising* the strategies, the students then began generating possible solutions to the problem. Unlike the *Characterisation* of problem which occurred only on the onset of problem solving, the *Characterisation* of strategies occurred throughout the task. Parallel to the survey and interview results, the findings at this phase confirmed *Characterise* as an activity that served as a precursor to all strategies, instead of a distinctive strategy.

In terms of the range of strategies employed during the problem-solving task, students employed a wider range of strategies to solve problems with the support of the taxonomic framework. There was an increase in the use of more productive thinking i.e., *Transfer* and *Transform*. The use of *Transform* occurred after the taxonomic framework was introduced. However, *Create* was evident throughout the problem-solving task. In spite of the increase in the range of strategies used and the fact that the framework facilitated the exercise of productive thinking, the most commonly employed strategies were *Replicate* and *Imitate.*

In terms of the solutions produced, the increase in the use of strategies simultaneously increased the number of solutions generated. The initial solutions produced were largely the *concept* and *process*-based solutions. However, after the taxonomic framework was introduced, there was an increase in the product-based solutions. Additionally, findings revealed that with the taxonomic framework, while the students *Characteirsed* the strateiges, they were able to expand and explain the *product*-based solutions with greater detail (elaboration).

In terms of the value of solutions, findings revealed that apart from novelty and usefulness, ethicality was demonstrated to be an important value for creativity. With the taxonomic framework, there were solutions that met all the three criteria i.e., novelty, usefulness and ethicality. Additionally, an important finding emerged from this finding was that the values of a creative outcome, which this taxonomic framework perceived should be appraised from a range of values from personal to global values, should not be seen as a 1:1 correspondence to each strategy. This was because even solutions created through *Replication* did not only have a personal value, but also values that concerned a wider community. Therefore, the value of a solution does not solely depend on which strategies are being employed.

The taxonomic framework appeared to facilitate student creativity and there was no particular concern raised toward the framework. However, students who worked on the task individually seemed to demonstrate better performance in terms of the range of strategies employed and the number of solutions produced. This finding informed that other factors outside the framework such as safe and supportive environment, trust and respect between partners, as well as openness to ideas and critical discussions must be created to avoid social inhibitions and to encourage collaborative and creative problem solving.

In conclusion, sufficient exposure to the taxonomic framework is necessary to provide time for the students to assimilate the concepts of the strategies and reflect on the use of the strategies in their thinking and actions. This would also be able to help the pairs to be familiar with each other and have sufficient time and opportunities to discuss the strategies in order to reach consensus.

9.3 Final Revision of the Taxonomic Framework

Based on the findings gained from all three empirical phases (survey, interview, and problem solving) with higher education students and lecturers, I finalised the taxonomic framework by doing the following:

(i) I added an introduction to the taxonomic framework to explain the goals of the framework and how the framework can be used by students and lecturers. I highlighted that the framework can be flexibly adapted based on specific needs, goals, contexts and users. I also explained that the strategies (*Replicate, Imitate, Transfer, Transform* and *Create*) are arranged in ascending order based on the level of creativity embodied in each strategy; however the framework does not prescribe a step-by-step model that the use of strategies must begin from *Replicate,* followed by *Imitate* through to *Create*. The inclusion of an introduction is in response to the concerns regarding the lack of understanding of how the framework may be used and the framework's flexibility (see APPENDIX H, page 304).

(ii) on the infographic diagram for each individual strategy, I specified what the values of a creative output could be i.e., novelty, usefulness and ethicality, but I also highlighted that the users could adapt and add other values that they deem appropriate. This amendment is in response to the findings that emerged from the problem-solving phase, which showed that other than novelty and usefulness, ethicality is another criterion for an outcome's value. Acknowledging that the value of a creative outcome may be context or situation specific, I stressed that the users could add other values appropriate to their purpose (see APPENDIX H, page 305-309).

(iii) on the infographic diagram for each individual strategy, I changed the linear 1:1 correspondence between strategy and value (e.g., *Replicate* only brings personal value). I noted that each strategy may create an output that may have a personal value, value that is relevant to the others, and a global value. For example, through *Replicate*, an outcome generated could be relevant to the creator themselves, the immediate context including friends and people they work with, a wider community including their professional community or organisation, the society and the global community. This is an amendment in response to the finding emerged from the problem-solving phase (see APPENDIX H, page 105-319).

(iv) in the "user reflection checklist", I added headings (e.g., understanding self, understanding the problem) to the checklist statements to create awareness in users on what they are reading. Each heading reflects a feature of a particular proposition (see APPENDIX H, page 310):

- The heading "Understanding self" refers to the "*person knowledge*" feature from the Mental proposition (tacit knowledge)
- The heading "Understanding problem" and "Understanding how to solve the problem" refer to the "*task knowledge*" feature from the Mental proposition (tacit knowledge)
- The heading "Understanding the strategies" refers to the "*strategic knowledge*" feature from the Mental proposition (tacit knowledge)
- The heading "Following intuition" refers to the "*intuitive ideation*" and "*intuitive judgment*" features from the Mental proposition (intuition)
- The heading "Understanding the state of mind" refers to the "*motivation*", "*open-mindedness*" and "*risk-taking*" features from the Trait proposition.
- The heading "Understanding the environment" refers to the "*resources*" feature from the Context proposition.

(v) On the "user reflection checklist", under the heading "Understanding the environment", I highlighted that the "*resources*" can be any resources in the context, including people they work with, financial support and time. Similarly, I highlighted that there may be other resources that are relevant to the users' contexts. This is an amendment in response to the finding emerged from the problem-solving task particularly regarding the paired students' performance. The examples of resources given is to help the users visualise the possible types of resources that could affect creativity, and simultaneously allow flexibility for them to adapt the list of resources based on their own contexts (see APPENDIX H, page 310).

The finalised taxonomic framework is shown in APPENDIX H.

9.4 Implications of the Study

This section discusses the implications drawn from and directed by the important findings of this research. By and large, the findings revealed the belief and individual experiences that creativity is a human capacity that can be learnt and taught. Findings of

Phase IV (problem solving task) further supported this premise by demonstrating that creativity could be facilitated through the use of a taxonomic framework, both in individual and collaborative task settings. Based on this finding, I will present the theoretical, pedagogical and methodological implications in the area of education and creativity.

9.4.1 Theoretical implications

Three major theoretical implications can be drawn from this study. First, the major contribution of this study was the development of the taxonomic framework for creativity based on a synthesis of the literature. Through the multiphase empirical investigation, this study developed a comprehensive conceptualisation of creativity that showed the interconnections among all known dimensions and features of creativity. Existing frameworks that classify creative actions (e.g., Eberle, 1971; Nilsson, 2011) do not explain factors that could facilitate these actions and the results of these actions could be. Consequently, this would lead to a tendency where the participants' understanding of creativity would be atomistic, instead of cohesive and comprehensive. This tendency has been demonstrated in this study where the participants mostly understood creativity from the Mental and Value propositions. This study contributed to the understanding of the process of creative engagement in a higher education context, factors that support the creative process, and the results of the creative process reflected in the outcomes and the values.

Second, this study provided empirical evidence to demonstrate that creativity can be stimulated by problems that are ill-defined without complete details and without any single expected route of solutions. Third, findings from this study supported the theory that creativity is a skill that can be taught and learned. Findings from this study revealed that creativity is a problem-solving process through the use of both reproductive and productive thinking, which are embodied in the five strategies incorporated in the framework to generate multiple solutions. Although creativity can be triggered by problems, the opportunities for creativity depend on the way in which the problem is presented to the individuals. The teachability and learnability of creativity thus challenges the Gestalt's view that postulates that creativity is a result of the "aha" moment. These findings therefore add a new dimension to the conceptualisation of creativity and provided empirical support that creativity and problem solving cannot be fully explained by the Gestalt and Associationalist theories, but a combination of both. The role of the creative strategies established by this study contributed to the information-processing account of problem solving.

9.4.2 Pedagogical Implications

I derived four pedagogical implications from the findings of this study. First, in teaching with and teaching for creativity, the provision of a suitable problem is essential. While the use of well-defined problems with fixed and expected routes for solutions requests conformity, to simulate creativity, ill-defined problems could stimulate “real” opportunities for students to practise and acquire creativity. To design a real-world task for students to address, educators need to ensure that the task fulfills the following criteria:

- The problem(s) presented in the task are authentic i.e., existing real-world problems.
- The problem(s) presented in the task allows students to interpret them from different perspectives.
- The task allows students to reorganise and reconceptualise their existing knowledge and experience to produce solutions to the problems.
- The problems presented in the task do not have a standard solution but allow for multiple solutions.

An example of such a task could be to ask students to identify environmental concerns (like energy wastage) in their institution and find ways to reduce or overcome this problem. Another example could be the one used in this study i.e., foreseeing and proposing roles and operations of a future university.

Presenting real-world problems in teaching also gives students ownership of the problem (Tan et al., 2009; Ulger, 2018), establish relevance for learning (Ulger, 2018; Tan et al., 2009), and connect the classroom to the larger community (Ulger, 2018). Getting students to solve real-world problems can be embedded in several approaches such as problem-based learning, project-based learning, inquiry-based learning and experiential learning. Through the use of the taxonomic framework, facilitating students to address a real-world scenario could involve the following stages:

(i) guiding students to define the problems (Characterisation) – problems that they know, need to know and do not know (Task knowledge - Mental Proposition).

(ii) introducing the creative strategies to develop knowledge and skills needed for addressing the problems, and developing awareness of skills they have, need to have and do not have (Task knowledge and Person knowledge – Mental proposition).

(iii) facilitating students to understand their own strengths and limitations that they need to capitalise and address (Person knowledge - Mental proposition).

(iv) making students aware of the different strategies for solving problems to assist them in generating solutions (Strategic knowledge - Mental proposition).

(v) facilitating students to be aware of the resources available to them and that they can work within constraints (Resources - Context proposition).

(vi) reminding students to be open minded and motivated (Trait proposition) when working with others (Context proposition).

(vii) getting students to present their decisions and the results of their solutions. The results would be in the form of an outcome (Concept, Process and/or Product - Outcome proposition) and the value it contains and in which degree (Value proposition).

(viii) giving students feedback or conducting a peer feedback session.

The second implication is related to scaffolding creativity. The taxonomic framework was valued by participants in this research for its embedded developmental structure that could act as a scaffold for learning creativity. This was aligned with Vygotsky's (1978) Zone of Proximal Development (ZPD), which proposes that the learner's progress from dependency to independence should be supported by the educators. In actual practice, findings showed that the taxonomic framework served as a scaffold for creativity in the problem-solving task. This was especially evident in the way the students in the problem-solving tasks used the framework as a step-by-step guide to explore, exercise, elaborate and assess the use of a particular strategy for problem solving. The strategies in the framework can therefore be used for explicit direct instructions where each strategy can be explained, demonstrated and modelled by the educators. This means that learning creativity can be a guided practice through carefully planned and sequenced lessons, with clear and detailed instructions and modelling, and frequent and systematic monitoring of student progress and feedback to students. Explicit direct instruction has been demonstrated to be effective in language learning (Alamri & Rogers, 2018; Dai & Liu, 2012), which may be an approach worth exploring in teaching and learning creativity.

Moreover, findings suggested that the taxonomic framework provides an explicit guide to progress from reproductive to productive thinking (the Strategies). Additionally, the framework also provides other features that guide educators to understand the factors that support creativity, which would help them create a nurturing environment (Context) that caters for the development of affective and cognitive dimensions of creativity (Mental). Besides, the framework also provides features that help both students and educators to understand their creative outcome (Outcome) and appreciate their creative outcome (Value).

Third, this study adds insights to the development of creativity through the We-paradigm. Unexpectedly, the findings showed that the framework facilitated creativity better in students who worked on the 20-minute problem solving task individually than those in ad hoc pairs. This difference could be due to reasons such as lack of familiarity and lack of trust that then reduced the efficiency of communication and collaboration between the students in pairs. This indicated the need for educators to set up a conducive and collaborative environment for creativity to be a co-constructed successfully. In ad-hoc groups, prior to presenting the creativity task, educators could spend time on developing rapport, and teach collaboration skills such as active listening, analysis, communication, dependability, openness, and team dynamics. A set of rules for group problem solving can be communicated to the students. These rules could include being open to the partners' ideas, respecting each other's ideas, and listen effectively (Context proposition).

The fourth implication drawn from this study concerns assessment of creativity. The taxonomic framework could be used for assessing student creativity. As lecturers from this study shared that the assessment of creativity was mainly done from the Outcome and Value propositions, such as the appearance of an academic poster largely based on the lecturers' intuition, expertise and experience, the taxonomic framework could allow educators and students to appraise creativity from more perspectives i.e., Mental, Trait, Context, Outcome and Value, and on a broad range of outputs, including essays, research, portfolio and video presentation. they could select only certain features or propositions for assessment or combine two or more propositions depending on the objectives of the assessment. The framework could also be used for self-assessment.

9.4.3 Methodological Implications

Two methodological implications can be drawn from this study. First, findings revealed that the definition of creativity is context bound. Creativity was defined differently when participants were asked to describe creativity as a concept and creativity as an individual's quality. Therefore the selection and design of instrument is important. The instrument needs to comprise various questions that allow participants to express the understanding of creativity from different perspectives. For example, in this study, participants were asked to define creativity as a concept and describe creative individuals. Having different questions that elicit participants' various perceptions of a topic would allow researchers to capture the participants' understanding of creativity in a more comprehensive manner.

Second, the multiphase research explored participants' understanding of creativity through a qualitative means. The qualitative means enabled a more detailed and elaborated response on the participants' perceptions of creativity. Previous studies (e.g., Aljughaiman & Mowrer-Reynolds, 2005; Gralewski & Karwowski, 2013) that largely examine creativity through quantitative means often have preselected constructs for creativity to be studied, hence not being able to explore other views of creativity that are not captured in the questionnaire. Additionally, the qualitative means employed in the problem-solving task allowed the identification of "why" and "how" the taxonomic framework facilitated creative behaviours. In previous findings, creativity research used only the quantitative method to measure creativity through fluency (number of solutions generated) and originality of solutions without analysing the processes involved in the creative process (e.g., Dumas et al., 2016; Kamis et al., 2020; Ulger, 2018). This qualitative method in this study enriches the data by allowing me to unravel the creative processes involved in problem solving and the quality of the solutions students generated.

9.5 Limitations of and Recommendations for the Research

The results reported herein should be considered in the light of some limitations. These limitations largely revolved around the sampling and design of the research.

Firstly, this study was conducted in one single institution i.e., an international university. This context had provided me with a multicultural context to investigate creativity from a wider perspective with a sample of diverse cultural and educational backgrounds. However, expanding the sampling to other educational contexts may have yielded richer data. For instance, a non-international, homogenous institution with a different institutional culture and ethos may have yielded a different result. As it stands further research has to be undertaken to establish transferability and generalisability of findings. This could be done by replicating this study with larger populations in various contexts. These contexts could be institutions made up of different institutional culture and ethos. Creativity is in some way shaped by one's culture, experience and environment. Therefore, replicating this research through a multiple case study of different institutions would verify if the framework could be applied across disciplinary, institutional and geographical contexts.

Secondly, findings of this research showed that the framework was perceived to be useful for teaching, learning and assessment. However in this study, the empirical findings did not show the practicality of the framework based on actual lecturers' implementation of the framework in their practice. Therefore this could be followed up by having in-service educators to implement the framework in their teaching practice. This way it could inform on the strengths and challenges of the framework in actual educational practice.

Thirdly, the findings from the problem-solving phase did not show a linear 1:1 correspondence between strategy and value, which was initially proposed by this study and previous theories (e.g., Cohen, 1989; Sternberg, 1999). This could be because the students were not asked to specifically elaborate on the consequences and impacts of their solutions at each level – creator (themselves), immediate context (among their peers), or a larger community. To further examine this dimension of creativity (Value proposition), future research could replicate the problem-solving phase of this study, by requiring students to elaborate on the consequences and level of significance or impact of their solutions.

Finally, the design of the problem-solving task allowed only a limited time for students to become familiar with the framework. The lack of exposure time had to a certain extent prevented the students from fully understanding and assimilating strategies in the framework. If a longer exposure time to the framework was provided, the strengths and limitations of the framework could have been better identified and analysed. Therefore future studies could incorporate the taxonomic framework into creativity intervention trainings as a standalone module or into any subject matter. The intervention would need to be lengthy i.e., eight to 14 weeks and involve participants from various disciplines to ascertain whether the framework facilitated creativity across disciplines.

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APPENDIX A

264 Features of creativity

No.	Features	Definition	Author
1.	Accumulative intuition	Intuition based on accumulative evidence or experience.	Glockner & Witterman (2010)
2.	Adaptive thinking	Thinking that applies existing solutions, techniques, or products to new scenarios or changed conditions. Doing things better.	Kirton (1976)
3.	Adequacy	in terms of the problem	Taylor (1975)
4.	Advance incrementation	Occurs when an idea is "ahead of its time".	Sternberg (1999)
5.	Advanced forward incrementation	Extending exemplar concepts in a clearly relevant direction, beyond the extent to which the exemplar might be expected to be applied.	Mecca & Mumford (2013)
6.	Agreeableness	The tendency to agree and go along with others rather than to assert one's own opinions and choices.	Toh & Miller (2016)
7.	Alteration	Reformation in terms of the degree of alteration to the problem.	Taylor (1975)
8.	Analogy	a cognitive process that has been hypothesized to be a major source of new concepts. Analogy is a fundamental cognitive process in which a *source* and *target* domain of knowledge are linked to one another by a systematic mapping of attributes and relations, which then allows for transfer of knowledge to the target	Chan & Schunn (2014
9.	Androgyny	Associated with creativity more strongly than being male or female, which suggests that the psychological is more relevant that the biological sex.	Costa et al. (2015)
10.	Appreciation	in relation to a problem	Taylor (1975)
11.	Approach-related traits	Traits related to openness to experience, extraversion, positive affectivity and power-motivation	Baas et al. (2013)
12.	Appropriateness	in terms of the problem	Taylor (1975)
13.	Appropriateness	The solution fits within task constraints.	Cropley et al. (2011)
14.	Arousing environment	Environment that awakens people.	Garcia-Garcia et al. (2019)
15.	Assimilation	handling unexpected situations by incorporating new experience into future behaviour.	Kim (1993)
16.	Associative intuition	Feeling how something is or how something is related to another, based on one's sensibility	Taura & Nagai (2017)
17.	Associative intuition	Intuition based on learning-retrieval process.	Glockner & Witterman (2010)

18.	Asymmetry	Reformation in terms of concrete product (which empirically produced generative changes).	Taylor (1975)
19.	Augmentation	A direct substitute, with functional improvement.	Puentedura (2006)
20.	Challenge	Degree to which people are involved in daily operations, long-term goals, and visions.	Ekvall (1996)
21.	Clarifier	Identifying the challenges.	FourSight (2017)
22.	Cognitive flexibility	Flexible processing of information	Baas et al. (2013)
23.	Cognitive persistence	Persistent probing, and systematically and incrementally combining elements and possibilities	Baas et al. (2013)
24.	Collaborative problem definition	problem generation, problem conceptualization, solution optimization, and solution implementation through collaboration.	Basadur et al. (2000)
25.	Combination	The solution makes use of new mixture(s) of existing elements.	Cropley et al. (2011)
26.	Combinational creativity	Unfamiliar combinations of familiar ideas	Boden (2004)
27.	Compactness	for a concrete product	Taylor (1975)
28.	Completeness	a concrete product (related to information quantity)	Taylor (1975)
29.	Completeness	The solution is well worked out and grounded.	Cropley et al. (2011)
30.	Complexity	The degree of range, depth, scope or intricacy of the information contained in the product.	Taylor (1975)
31.	Complexity (challenge)	Willingness to take up challenges.	Williams (1969)
32.	Comprehensiveness	in terms of the field	Taylor (1975)
33.	Concept generation	Generation of fundamental concept.	Chan & Schunn (2014)
34.	Condensation	The degree to which the product simplifies, unifies and integrates.	Taylor (1975)
35.	Conflicts	Presence of personal and emotional tensions in the organization.	Ekvall (1996)
36.	Conscientiousness	The tendency to be careful, on-time for appointments, to follow rules and to be hardworking.	Toh & Miller (2016)
37.	Constructive intuition	Intuition based on construction of mental representations.	Glockner & Witterman (2010)
38.	Continuum	A coherent organisation to arrange behaviours of varied degrees.	Cohen (2012)

39.	Convincingness	The beholder sees the solutions as skillfully executed, well-finished.	Cropley et al. (2011)
40.	Correctness	The solution accurately reflects the conventional knowledge and/or technique.	Cropley et al. (2011)
41.	Creating by extending a field	The individual adds something new to a field of endeavour that he or she has mastered, thereby extending it. The outcome is valued especially by those in the field.	Cohen (2012)
42.	Creating by revolutionising a field	The individual reconceptualises and revolutionises the field in which he or she functions or creates a new field by combining aspects of different enterprises so that it is passed to new learners in its revised state. The outcome is greatly valued by both those in and outside the field.	Cohen (2012)
43.	Creative magnitude	Level of creativity from one that is of value to the person’s learning to one that is a breakthrough.	Beghetto (2019)
44.	Cross-fertilisation	Generation in terms of out-of-field effects	Taylor (1975)
45.	Curiosity (willingness)	Willingness to know something and to find out something.	Williams (1969)
46.	Debates	Occurrence of encounters and disagreements between viewpoints, ideas, and differing experiences and knowledge.	Ekvall (1996)
47.	Define	Clearly articulate the problem you want to solve.	Interaction Design Foundation (2017)
48.	Deliberate selection	Deliberative processing in selecting creative ideas.	Zhu et al. (2017)
49.	Demonstrating talents	The individual develops products, approaches, or ideas in a particular domain that are rare compared to age peers, but are not new to the world.	Cohen (2012)
50.	Design	Technique which can be obtained through the structural analysis of the relationship between principle, element combination and idea expression.	Kong & Chae (2005)
51.	Determined	Intrinsic motivation that drove creative people to not give up easily and to have passion and persistence.	Karpova et al. (2013)
52.	Developer	Bringing ideas to life.	FourSight (2017)
53.	Developing heuristics	Through instruction, the individual develops alternatives and thinks flexibly, fluently, originally, and elaboratively, makes transformations, uses, critical thinking, systematically uses problem solving process in a variety of subject areas. The outcomes may be of limited value to others.	Cohen (2012)
54.	Diagnosis	The solution draws attention to shortcomings in other existing solutions.	Cropley et al. (2011)
55.	Diagramming	A methodology of gathering data through a variety of media, applications, sensations and situations, that all intermingle to provide an enriched understanding.	Barry (2017)

56.	Dialectical thinking	breaking sets, attention to contradiction (and synthesizing contradiction), being aware of the complex relationships between things, and understanding that one's own thoughts will change.	Paletz & Peng (2009)
57.	Diffusion impact	its out-of-field effect	Taylor (1975)
58.	Divergent thinking	Includes preference for high ideation; low evaluation; high intuition; low reasoning; high innovation; low adaptation; more exploration than assimilation; high tolerance for ambiguity	Costa et al. (2015)
59.	Doing – procedures	The different techniques creators use at different stages of their activity.	Glaveanu et al., (2013)
60.	Doing – stages	The different stages or phases of creative work and how it advances.	Glaveanu et al., (2013)
61.	Doing – time/place	When and where creative work is done.	Glaveanu et al., (2013)
62.	Doing – tools	The material tools used.	Glaveanu et al., (2013)
63.	Durability	The solution is reasonably strong.	Cropley et al. (2011)
64.	Dynamism/livelin ess	The eventfulness of life in the organization.	Ekvall (1996)
65.	Elaboration	The crucial elements of team members constructively discussing each other's suggestions and integrating the input different members provide.	Hoever et al. (2012)
66.	Elaboration	The details given to a solution.	Torrance (1979)
67.	Elaborative thinking	The ability to expand details in a solution.	Williams (1969)
68.	Elegance	For concrete product	Taylor (1975)
69.	Elegance	The appearance of the solution.	Cropley et al. (2011)
70.	Elegant	The appearance of the solution.	Mecca & Mumford (2013)
71.	Emergentive originality	The most original ideas from which innovators derive their creations are maximally abstract where a person creates an entirely new way of perceiving a significantly large portion of the environment. An original idea is most difficult to create since it derives most fully from the transactions of personal perception.	Taylor (1975)
72.	Emotion	Emotional experience at the beginning, during and at the end of activity.	Glaveanu et al., (2013)
73.	Emotional intelligence	The ability to perceive, use, understand, manage, and handle emotions.	Costa et al. (2015)
74.	Emphatise	Develop a deep understanding of the challenge.	Interaction Design Foundation (2017)
75.	Employee creativity	The development of ideas about practices, procedures, products, and/or services that are (a) novel and (b) potentially useful to an organization.	Coelho et al. (2011)

76.	Episodic memory	A neurocognitive system that supports the ability to recollect specific personal experiences that happened in a particular time and place.	Madore et al. (2015)
77.	Experiential intuition	Intuition that enables instantaneous decision-making following patterns recognised based on one's experience	Taura & Nagai (2017)
78.	Exploratory creativity	Generation of novel ideas by the exploration of structured conceptual spaces	Boden (2004)
79.	Expressive spontaneity	The behaviour is free from prior formal training, is manifestly unrehearsed, and is suggestive of improvisation. Little changes will be made.	Taylor (1975)
80.	Extension strategies	An imitation strategy through replication, redefinition, forward incrementation and advanced forward incrementation.	Mecca & Mumford (2013)
81.	Extrinsic motivation	Behavior that is driven by external rewards.	Zhu et al. (2018)
82.	Fertileness	Generation in terms of the field	Taylor (1975)
83.	Financial constraints	Input restrictions, as they preclude the possibility to acquire some inputs that would be necessary to implement a well-known course of action.	Scopelliti et al (2014)
84.	Flexibility	The ability to generate solutions for different perspectives.	Torrance (1979)
85.	Flexible thinking	The ability to generate solutions for different perspectives.	Williams (1969)
86.	Fluency	The ability to produce many solutions.	Torrance (1979)
87.	Fluent thinking	The ability to produce many solutions.	Williams (1969)
88.	Formulation	Materials and process are well-established but latitude is permitted, and variation – within agreed limits – may be welcomed.	Fennell (1993)
89.	Forward incrementation	Extending exemplar concepts in a clearly relevant direction.	Mecca & Mumford (2013)
90.	Foundationality	The solution suggests a novel basis for further work.	Cropley et al. (2011)
91.	Freedom	Independence in behavior exerted by the people in the organization.	Ekvall (1996)
92.	Fruitfulness	Generation in terms of the problem	Taylor (1975)
93.	Functional potential	concrete product	Taylor (1975)
94.	Functionality	The ability of physical environment to facilitate creative activities.	Dul (2019)
95.	General value	out-of-field effects.	Taylor (1975)
96.	Generation	The degree to which the product initiates activity in oneself or others as an effect of the product i.e., the extent to which it generates or produces new ideas.	Taylor (1975)
97.	Generation	The solution offers a fundamentally new perspective on possible solutions.	Cropley et al. (2011)
98.	Genesis	The quality of forward looking	Cropley et al. (2011)

99.	Germinal	Generation in terms of a concrete product	Taylor (1975)
100.	Germinality	The solution suggests new ways of looking at existing problems.	Cropley et al. (2011)
101.	Goal difficulty	Difficulty of a goal to be achieved.	Espedido & Searle (2018)
102.	Gracefulness	The solution well-proportioned, nicely formed.	Cropley et al. (2011)
103.	Harmaniousness	The elements of solution fit together in a consistent way.	Cropley et al. (2011)
104.	Hedonics	The valence or degree of attraction the product commands.	Taylor (1975)
105.	Idea support	Ways new ideas are treated. In the supportive climate, ideas and suggestions are received in an attentive and professional way by bosses, peers, and subordinates.	Ekvall (1996)
106.	Idea time	Amount of time people can use (and do use) for elaborating new ideas. In the high idea-time situation, possibilities exist to discuss and test suggestions not included in the task assignment.	Ekvall (1996)
107.	Ideate	Brainstorm potential solutions, select and develop your solution.	Interaction Design Foundation (2017)
108.	Ideator	Generating ideas for solutions.	FourSight (2017)
109.	Imagination (intuition)	Using intuition to imagine to form concepts and sensations in mind.	Williams (1969)
110.	Imitation	Modeling after an exemplar	Rook & Knippenberg (2011)
111.	Imitation	Strategic copying of a model/ remaking.	Hobbbs & Friesem (2019)
112.	Impact	to the field	Taylor (1975)
113.	Implementer	Implementing the solutions.	FourSight (2017)
114.	Impulsion	The motivation for the action.	Glaveanu et al., (2013)
115.	Incrementation	Occurs when a piece of work takes the field where it is and moves it forward from that point in the space of contributions in the direction work is already going.	Sternberg (1999)
116.	Incrementation	The solution extends the known in an existing direction.	Cropley et al. (2011)
117.	Innovation	Materials and processes are discretionary but work is within established conventions.	Fennell (1993)
118.	Innovative flexibility	Involving ideational flexibility and a greater degree of originality, resulting in very significant functional improvements from the previous. It involves relevant and unique variations, modifications, and adaptations of a unique idea into an independent creative outcome.	Taylor (1975)
119.	Innovative thinking	Thinking that produces new solutions. Doing things differently.	Kirton (1976)

120.	Input constraint	The unavailability of resources such as time, human capital, funds, excess cash, and materials that could be used in the service of creativity and innovation activities.	Acar et al. (2018)
121.	Insight	Express ideas via the Aha moment	Musta'amal et al. (2009)
122.	Integration	its relation to the field	Taylor (1975)
123.	Integration	Occurs when a contributor suggests putting together kinds of ideas that formerly were seen as distinct and unrelated or even as opposed.	Sternberg (1999)
124.	Integrative capability	The ability to perform external knowledge acquisition and internal knowledge integration.	Qu & Liu (2017)
125.	Intrinsic motivation	A kind of intrinsic value of personality expression, and it is thus connsidered a need, a driving force or a sense of satisfaction.	Horng et al. (2016)
126.	Intrinsic motivation	Behavior that is driven by internal rewards.	Costa et al. (2015)
127.	Intrinsic motivation	Behavior that is driven by internal rewards.	Zhu et al. (2018)
128.	Intrinsic motivation	The extent to which an employee is excited about a work activity and is motivated to engage in it for the sake of the activity itself.	Coelho et al. (2011)
129.	Intuition	A perceptual process, constructed through a mainly subconscious act of linking disparate elements of information.	Raidl & Lubart (2001)
130.	Intuitive insight	Creating solution which entails a new knowledge, a new value and beautiful.	Dorfler & Ackermann (2012)
131.	Intuitive judgment	Deciding about an alternative or about direction, whether an action is good or evil, beautiful or ugly.	Dorfler & Ackermann (2012)
132.	Intuitive selection	Intuitive processing in selecting creative ideas	Zhu et al. (2017)
133.	Inventive ingenuity	Exceeding mere skill and manipulating concrete elements in the environment inventively by discovering and combining environmental parts to solve problems.	Taylor (1975)
134.	Inventory	A material for assessing products.	Taylor (1975)
135.	Job complexity	Jobs that are rich in autonomy, variety, identity, feedback, and significance.	Coelho et al. (2011)
136.	Knowledge integration	A judicious mixture of model based reasoning, information sharing, and case based reasoning.	Kim (1993)
137.	Knowledge integration	A process to create new architectural knowledge - "a platform for carrying out new product and market combinations"	Men et al. (2018)

138.	Learning something new: universal novelty	The individual constructs relationships new to him or her but not to the world. Everyone who learns that field must make the same constructions, which remain in the realm of thought.	Cohen (2012)
139.	Making connections that are rare compared to peers	The individual develops products, ideas, or approaches that are unusual or rare compared to peers, but are not new to the world.	Cohen (2012)
140.	Matching intuition	Intuition based on comparisons with exemplars.	Glockner & Witterman (2010)
141.	Meaning	The symbolic meaning concealed in a set of physical properties of the environment.	Dul (2019)
142.	Measurement	Instrument for measuring structure and climate for an organisation.	Ekvall (1996)
143.	Metacognitive strategies	Strategies involving self-planning, self-monitoring, self-modifying, and self-evaluating.	Safitri et al. (2018)
144.	Method	A participatory method that provides a holistic account of the relationships and experiences.	Gillies & Robinson (2012)
145.	Methodology	Processes for idea generation.	Moon & Han (2016)
146.	Methodology Design	A model for understanding the problem situation in terms of a series of systemically interrelated research questions that express the purposes of the researcher (usually in dialogue with others), each of which might need to be addressed using a different method, or part of a method.	Midgley (1996)
147.	Model	A guide to encouraging and integrating behaviours.	Williams (1969)
148.	Model	A representation for characterising contributions.	Sternberg (1999)
149.	Modification	Allows for significant task redesign.	Puentedura (2006)
150.	Modification/incremental development	Modifying existing designs.	Eckert et al. (2012)
151.	Mood	The ability of physical items to include emotional responses over the short term.	Dul (2019)
152.	Motivational disposition	A product of cognitive contents and processes, elaborated in a series of steps, focused sequentially on identifying the input and elaborating its meaning.	Kreitler & Casakin (2009)
153.	Neuroticism	The trait disposition to experience negative effects.	Garcia-Garcia et al. (2019)
154.	Novelty	originality to the field	Taylor (1975)
155.	Novelty	The degree of newness.	Garcia-Garcia et al. (2019)
156.	Novelty	The quality of being new.	Men et al. (2018)

157.	Novelty	The quality of being new.	Qiu & Liu (2017)
158.	Novelty	The state of being new.	Cropley et al. (2011)
159.	Obstable	Difficulties and/or limitations on the whole or at different stages.	Glaveanu et al., (2013)
160.	Open-minded	Characteristics of adaptability and flexibility	Karpova et al. (2013)
161.	Openness	The trait disposition of being open-minded.	Garcia-Garcia et al. (2019)
162.	Openness to experience	A dimension of personality reflecting the tendency toward cognitive exploration	Kaufman et al. (2016)
163.	Openness to experience	High empathy, emotional expressiveness, and good capacities of affect regulation.	Costa et al. (2015)
164.	Openness to experience	One's willingness to engage in new ideas, one's appreciation for esthetics, for desire for depth of discussion.	Puryear et al. (2017)
165.	Operability	The solution is easy to use.	Cropley et al. (2011)
166.	Original	The novelty of the solution.	Mecca & Mumford (2013)
167.	Original thinking	The ability to produce unique solutions.	Williams (1969)
168.	Originality	Considered less important than generation or reformation. It is evaluation as to the degree of the product's usefulness, uncommonness, or statistical infrequency.	Taylor (1975)
169.	Originality	The uniqueness of a solution.	Torrance (1979)
170.	Originality	Uniqueness.	Hobbbs & Friesem (2019)
171.	Origination	Materials and processes are discretionary and work is either without precedent or significantly extends beyond established conventions.	Fennell (1993)
172.	Output constraints	The factors that define the end result of the creative processes, such as the constraints on what the output should (not) contain (e.g., use of certain materials or colors) and/or achieve (e.g., minimum product quality or performance specifications).	Acar et al. (2018)
173.	Pathfinding	The solution opens up a new conceptualisation of the issues.	Cropley et al. (2011)
174.	Performance	The solution does what it is supposed to do.	Cropley et al. (2011)
175.	Perspective taking	A cognitive process or capacity of imagining the world from another person's point of view.	Han et al. (2017)
176.	Perspective taking	The attempt to understand the thoughts, motives and feelings of another person.	Hoever et al. (2012)
177.	Physical environment	An environment that can stimulate creativity.	Dul (2019)

178.	Plasticity	A tendency to explore and engage flexibly with novelty, in both behavior and cognition.	Silvia et al. (2009)
179.	Playfulness/humour	Spontaneity and ease displayed within the workplace.	Ekvall (1996)
180.	Pleasingness	The beholder finds the solution neat, well done.	Cropley et al. (2011)
181.	Popularity	out-of-field effects	Taylor (1975)
182.	Positive affect	Positive emotions.	Costa et al. (2015)
183.	Prescription	The solution draws how existing solutions could be improved.	Cropley et al. (2011)
184.	Proactive personality	Individuals with proactive personality are less likely to be restricted by situational pressures, can challenge the status quo, and can even influence the environment to create change.	Horng et al. (2016)
185.	Problem finding	The process of asking questions before solving a problem. it is a process of identifying, defining, expressing and constructing problems.	Paletz & Peng (2009)
186.	Process	A series of steps involved to implement an idea.	Turnbull & Wheeler (2014)
187.	Process constraints	The restrictions that determine the steps to be followed throughout innovation and creativity processes, such as use of a formal NPD procedure or specific rules in brainstorming sessions.	Acar et al. (2018)
188.	Process knowledge	Cognitive creativity skill that entails actions derived from instances where individuals in the design team express knowledge of underlying cognitive processes and aspects and utilize it to facilitate their own and their team's creative process.	Valgeirsdottir & Onarheim (2017)
189.	Producing information	The individual investigates problems that are real to him or her, producing new information, but of limited scope, in areas of new interest and developing knowledge. The outcomes may be of limited value to others.	Cohen (2012)
190.	Prognosis	The solution helps the beholder to anticipate likely effects of changes.	Cropley et al. (2011)
191.	Prototype	Design a prototype to test all or part of your solution.	Interaction Design Foundation (2017)
192.	Recognition	The beholder sees at once that the solution makes sense.	Cropley et al. (2011)
193.	Reconstruction	Linking the exemplar to a past performance	Mecca & Mumford (2013)
194.	Reconstruction	The solution shows that an approach previously abandoned is still useful.	Cropley et al. (2011)
195.	Reconstruction/redirection	Involves moving the field backward to a point it previously was at but then moving in a direction different from that it has moved in.	Sternberg (1999)
196.	Redefinition	Allows for the creation of new tasks, previously inconceivable.	Puentedura (2006)
197.	Redefinition	Approaching exemplar concepts from an alternate perspective.	Mecca & Mumford (2013)
198.	Redefinition	Involves a change in perception as to where the field is.	Sternberg (1999)
199.	Redefinition	The solution helps the beholder see new and different ways of using the solution.	Cropley et al. (2011)

200.	Redirection	Involves taking the field where it is at a given time but attempting to move it in a new direction.	Sternberg (1999)
201.	Redirection	Shifting exemplar concepts in an alternate direction	Mecca & Mumford (2013)
202.	Redirection	The solution shows how to extend the known in a new direction.	Cropley et al. (2011)
203.	Reduction	in its relation to the problem	Taylor (1975)
204.	Reformation	The extent to which the product introduces significant change or modification in oneself or others.	Taylor (1975)
205.	Reinitiation	Initiating a new set of actions based on concepts present in the exemplar.	Mecca & Mumford (2013)
206.	Reinitiation	Occurs when a contributor suggests that a field or subfield has reached an undesirable point or has exhausted itself moving in the direction that is moving. The contributor suggests moving in a different direction from a different point in the multidimensional space of contributions.	Sternberg (1999)
207.	Reinitiation	The solution indicates a radically new approach.	Cropley et al. (2011)
208.	Relationship with people	Relationship with supervisor, clients and co-workers.	Coelho et al. (2011)
209.	Relaxing environment	Environment that helps people to feel relaxed.	Garcia-Garcia et al. (2019)
210.	Relevance	Whether the solution is effective and useful to the problem.	Cropley et al. (2011)
211.	Relevancy	The extent to which the product satisfactorily provides a solution to a problem.	Taylor (1975)
212.	Remoteness	as to the problem, its remoteness in terms of the solution	Taylor (1975)
213.	Reorganisation	in terms of out-of-field effects.	Taylor (1975)
214.	Replacement strategies	A strategy involving redirection, reconstruction, reinitiation and synthesis.	Mecca & Mumford (2013)
215.	Replication	Applying an exemplar solution in an alternate context.	Mecca & Mumford (2013)
216.	Replication	Helps solidify the current state of the field.	Sternberg (1999)
217.	Replication	Materials and processes are prescribed with little or no latitude.	Fennell (1993)
218.	Replication	Reproducing a piece of work.	Makel & Plucker (2014)
219.	Replication	The solution uses existing knowledge to generate novelty.	Cropley et al. (2011)
220.	Restructuring	the amount of change it produces in terms of the field	Taylor (1975)
221.	Risk taking	Tolerance of uncertainty and ambiguity in the workplace.	Ekvall (1996)
222.	Risk taking	Willingness to take risk.	Karpova et al. (2013)
223.	Risk taking	Willingness to take risks.	Shen et al. (2018)
224.	Risk taking (courage)	The courage to take risks	Williams (1969)

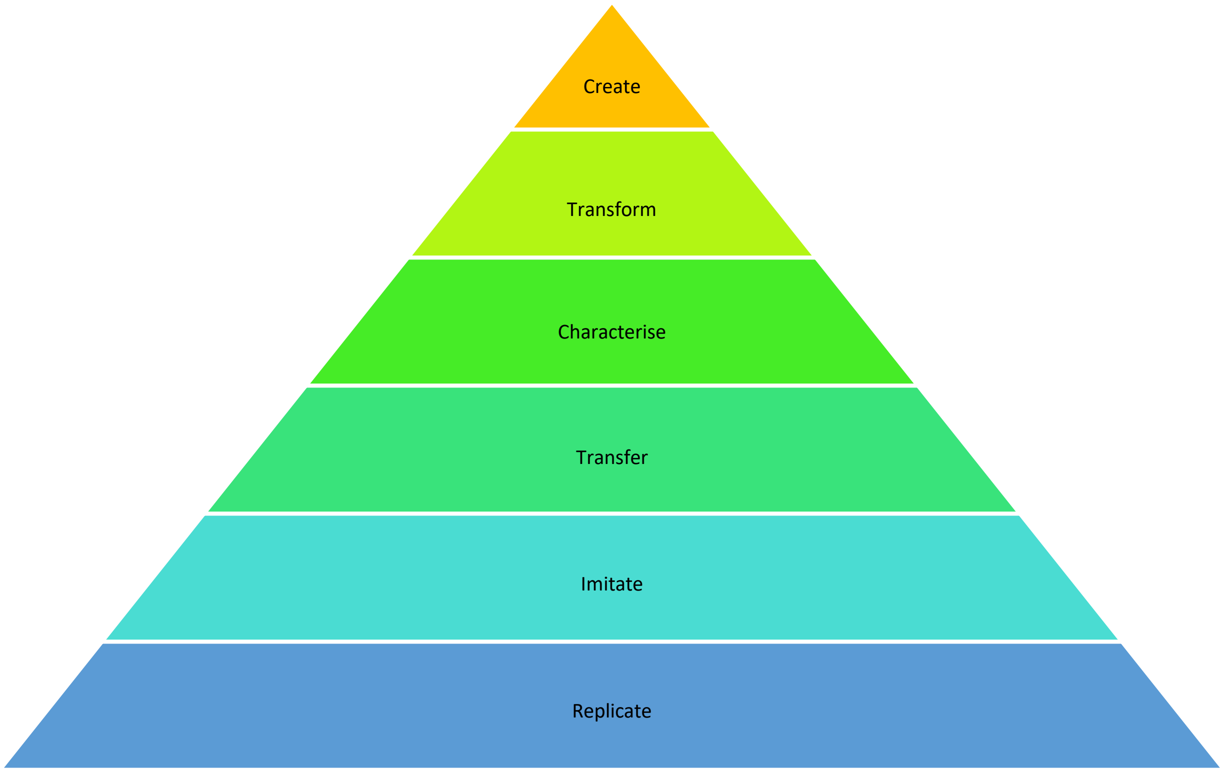
225.	Risk-taking	Willingness to be adventurous.	Tyagi et al. (2017)
226.	Role ambiguity	The extent to which an employee thinks he/she has inadequate knowledge to perform his/her job.	Coelho et al. (2011)
227.	Role conflict	Occurs when an employee perceives an incompatibility between expectations of two or more role set members, such as a sales manager, customers, co-workers, and family.	Coelho et al. (2011)
228.	Safety	The solution is safe to use.	Cropley et al. (2011)
229.	Scale	An assessment scale for a product.	Cropley et al. (2011)
230.	Self-awareness	Being awareness of oneself and predicting or expecting success and failure.	Silvia & Philip (2003)
231.	Self-evaluation	Assessing how one oneself is doing.	Silvia & Philip (2003)
232.	Seminality	The solution draws attention to previously unnoticed problems.	Cropley et al. (2011)
233.	Sensitivity	Consciousness of what needs to be solved and how to solve them.	Musta'amal et al. (2009)
234.	Stability	a tendency to maintain stability and avoid disruption in emotional, social, and motivational domains.	Silvia et al. (2009)
235.	Strategic knowledge	Strategic knowledge is not a set of prescriptions but often takes the form of proposals for action within the specific demands of a situation, which may be used to breakout of a period of fallow thinking or an unproductive solution space. Where fixation of ideas occurs, the use of strategic knowledge involves applying well-known domain and context knowledge in surprising and imaginative ways.	Kvan & Candy (2000)
236.	Strategic knowledge management	Strategic planning related to the crafting and implementing of a knowledge strategy	Cabrilo & Dahms (2018)
237.	Structured uncertainty	Presenting students with opportunities to work through uncertainty in a well-planned learning environment.	Beghetto (2019)
238.	Substitution	A direct substitute, with no functional change.	Puentedura (2006)
239.	Sustainability	The solution is environmentally friendly.	Cropley et al. (2011)
240.	Synthesis	Integration of the exemplar with another exemplar or multiple other exemplars to produce a solution.	Mecca & Mumford (2013)
241.	Task difficulty	The level of activity that requires a significant amount of cognitive or physical effort to develop the learner's knowledge and skill levels.	Chae et al. (2015)
242.	Team collaborative climate	Climate that motivates competition among team members.	Zhu et al. (2018)
243.	Team competitive climate	Climate that motivates collaboration among team members.	Zhu et al. (2018)

244.	Team prosocial motivation	Willingness among team members to expend efforts to benefit others	Qu & Liu (2017)
245.	Technical creativity	It is a process of strictly adhering to external rules of production. It can take on the character of conformity unless the skills are tempered or transacted by individuality. The natural behaviour may become inhibited, but the finished products can be described as a result of productive skill.	Taylor (1975)
246.	Test	Engage in a continuous short-cycle innovation process to continually improve your design.	Interaction Design Foundation (2017)
247.	Tolerance for ambiguity	The tendency to appreciate new ideas, values, feelings and behaviours.	Toh & Miller (2016)
248.	Tolerance of ambiguity	Being comfortable with uncertainty.	Williams (1969)
249.	Tolerance of ambiguity	The ability to accept feelings of anxiety and psychological discomfort naturally provoked by ambiguity associated with new, difficult situations.	Zenasni et al. (2008)
250.	Transferability	The solution offers ideas for solving apparently unrelated problems.	Cropley et al. (2011)
251.	Transformational creativity	Transformation of one or more dimension of the space, so that new structures can be generated which could not have arisen before. (e.g. changing the rules)	Boden (2004)
252.	Trust/openness	Emotional safety in relationships.	Ekvall (1996)
253.	Undergoing – material	The relation to the physical/material environment	Glaveanu et al., (2013)
254.	Undergoing – social	The relation to the social environment and the nature of social interactions	Glaveanu et al., (2013)
255.	Undergoing before doing	Everything that prepared the creator for the work.	Glaveanu et al., (2013)
256.	Undergoing final result	Perceiving and judging the final outcome.	Glaveanu et al., (2013)
257.	Unification	its out-of-field relation	Taylor (1975)
258.	Uniqueness	originality for a concrete product	Taylor (1975)
259.	Universality	its out-of-field effects	Taylor (1975)
260.	Usefulness	The degree of usefulness.	Garcia-Garcia et al. (2019)
261.	Usefulness	The quality of being useful.	Men et al. (2018)

262.	Usefulness	The quality of being useful.	Qiu & Liu (2017)
263.	Utility	in regard to the field	Taylor (1975)
264.	Vision	The solution suggests new norms for judging other solutions-existing or new.	Cropley et al. (2011)

APPENDIX B
Prototype Taxonomic Framework for Creativity (Developed from Phase 1)

Taxonomic Framework for Creativity



Replicate

What is it?

To reproduce in the identical image of the existing product or solution to address an identical or similar problem or situation.

The replication is by way of the:

(1) adoption of an existing product or solution, or

(2) in parts, the form, idea and/or processes of the product or solution.

What is the outcome?

The solution can be a concept, process and/or product.

What is the impact?

The product or solution:

- addresses personal problems
- is valuable to the problem solver
- solves common day-to-day problems.

Example

Problem: Organ failure

Solution: Using surgery to remove the affected area of the organ

Explanation: The use of surgery has long existed, and therefore if this way is used to solve the problem (treat organ failure), there is very low innovation in the solution.

Check yourself:

- ❑ I know the strengths I have to solve this problem.
- ❑ I know the limitations I need to overcome in solving this problem.

- ❑ I know the problem that needs to be solved.
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- ❑ I know the steps to solve the problem.
- ❑ I know the knowledge I need to better understand the problem.

- ❑ I know why I want to use this strategy to solve this problem.
- ❑ I know the existing products or solutions that I can adopt or adapt.

- ❑ I can judge if the way I play with the idea can solve the problem.
- ❑ I can judge if the product or solution I produce can solve the problem.

- ❑ I am motivated to solve this problem.
- ❑ I am open to new possibilities.
- ❑ I try to produce many solutions without worrying about right or wrong.
- ❑ I try to use whatever resources available to me.

Imitate

What is it?

To model after an existing product or solution not in an identical manner to address a similar problem or situation

The imitation may be an adaptation of:

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Example

Problem: Organ failure

Solution: Using pacemakers to treat heart failure; using dialysis machines to treat kidney failure

Explanation: The pacemaker mimics the human heart rhythm to help the heart beats normally. The dialysis machine mimics some functions of the kidney to remove waste products from the blood.

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Transfer

What is it?

To develop a product or solution by borrowing from other resources of similar nature

The transfer may be in the adaption of:

(i) **the entire existing product or solution from an unrelated field or**

(ii) **in parts the form, idea and/or processes of the original from a related or unrelated field.**

What is the outcome?

The solution can be a concept, process and/or product.

What is the impact?

The product or solution:

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Example

Problem: Organ failure

Solution: Using chemotherapy to treat organ failure, especially organ failure caused by cancer

Explanation: Chemotherapy uses Nitrogen Mustard gas as an anti-cancer drug. Nitrogen Mustard gas was initially used to make weapons for wars. The use of Nitrogen Mustard is transferred to the medical field to treat organ failure or cancer.

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Characterise

What is it?

To develop a product or solution through the characterisation of the problem.

The product or solution may be arrived at through:

(i) **the adoption of an existing resource or**
(ii) **by adapting the form, idea and/or process of an existing product or solution.**

What is the outcome?

The solution can be a concept, process and/or product.

What is the impact?

The product or solution:

- addresses problems or situations related to a professional communities and organisations.
- solves problems in specialist disciplinary areas.

Example

Problem: Organ failure

Solution: Using Targeted Therapy to control the growth of cancer cells that cause organ failure.

Explanation: Targeted Therapy is developed to help stop the cancer cells from growing. This solution is a "characterisation" because it is developed after analysing that chemotherapy will also kill the healthy cells, and this leads to side effects like hair loss, blood loss etc.

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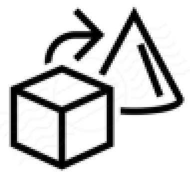

Transform

What is it?

To synthesise features from two or more products or solutions to develop an advanced product or solution to address a new problem or situation.

The product or solution may be arrived at through the:

(i) **manipulation and**

(ii) **reengineering of the form, idea and/or process of existing products or solutions.**

What is the outcome?

The solution can be a concept, process and/or product.

What is the impact?

The product or solution:

- addresses global problems or situations.
- solves problems by building upon existing knowledge or solutions.
- may be original or novel.

Example

Problem: Organ failure

Solution: Using organ transplant to treat organ failure

Explanation: Organ transplant is a synthesis of different medical solution features. Among these include the features of a surgery and immunotherapy (immunosuppressive therapy – to reduce the strengths of the immune system so that the body is less likely to reject the transplanted organ).

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- ❑ I try to produce many solutions without worrying about right or wrong.
- ❑ I try to use whatever resources available to me.

What is it?

To hypothesise and generate completely anew, products or solutions or synthesise diverse existing knowledge in unconventional ways to create new products or solutions.

A completely new product or solution will be arrived at through the creation of the form, idea and/or process that is significantly different, relevant and more advanced from existing product or solutions.

Create

Example

Problem: Organ failure

Solution: Using "cloning" to treat organ failure

Explanation: "Cloning" is a "creation" because it is unconventional – it breaks the conventional idea that organ failure can only be treated either by removing the affected organ areas, killing or controlling the growth of bad cells. "Cloning" brings a new solution by producing/cloning identical human cells or even the whole organ to replace the failed organ.

What is the outcome?

The solution can be a concept, process and/or product.

What is the impact?

The product or solution:

- addresses global problems or situations.
- solves problems using revolutionary ideas and methods.
- is original or novel.

Check yourself:

- ❑ I know the strengths I have to solve this problem.
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APPENDIX C
Survey

Programme : ________________________________

Nationality : _________________________________

H/P No. : ________________________________ (optional)

Assessment of Taxonomic Framework for Creativity

This study aims to develop a taxonomic framework for creativity for the higher education context. There are two (2) sections in this questionnaire. In the first section, you will answer questions related to the creative strategies in the taxonomic framework. In the second section, you will answer questions related to the usefulness of the taxonomic framework. You may refer to the Supplementary Document for more details of the framework.

Your opinions and feedback are greatly appreciated.

<u>Section A</u>

1. What is “creativity” to you?

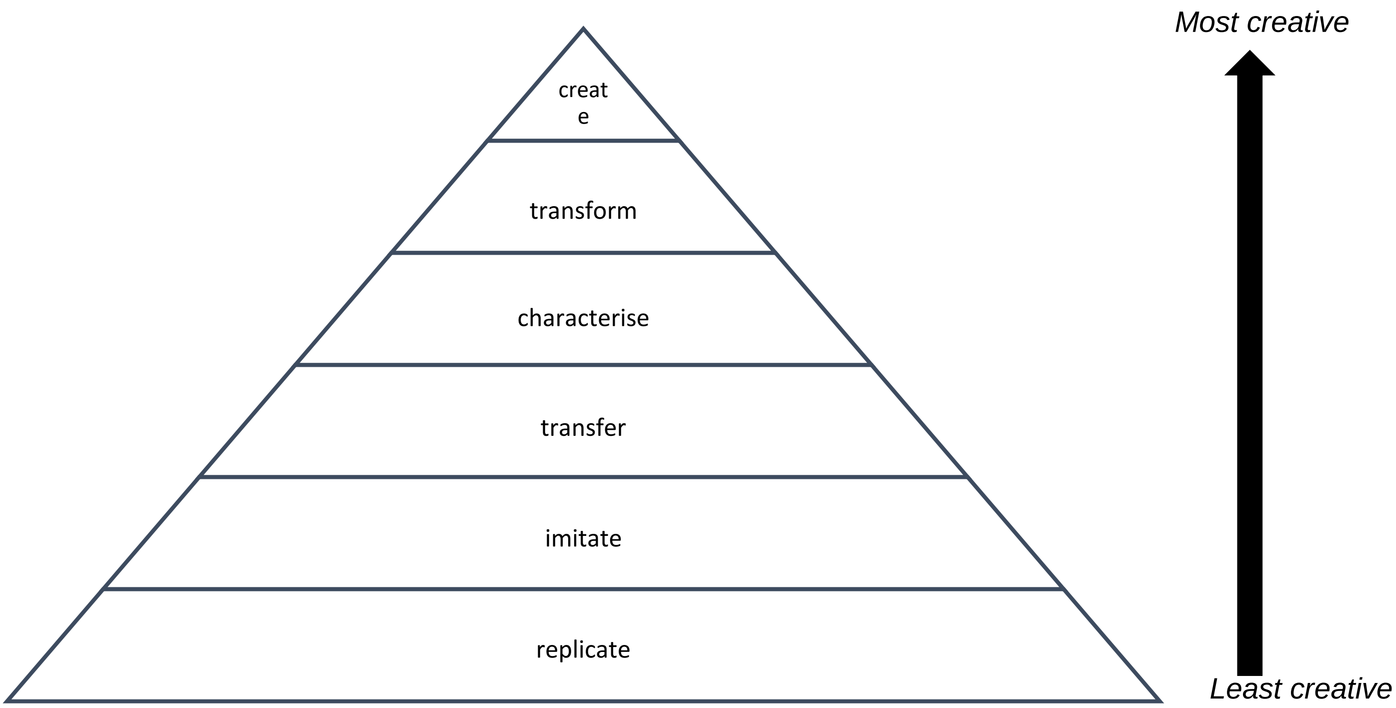
2. How would you order the strategies below, with the least creative being 1, and the most creative being 6? *(One number can only be used once.)*

Glossary

- Form – the appearance of the product or solution (e.g. shapes, sizes etc.)
- Idea – the concepts, theories and/or principles that made up the product or solution
- Process – the techniques or skills that are required to develop the product or solution

Ranking	Strategy	Definition of Strategy
	Transform	To synthesise features from two or more products or solutions to develop an advanced product or solution to address a new problem or situation. The product or solution may be arrived at through the manipulation and reengineering of the form, idea and/or process of existing products or solutions.
	Replicate	To reproduce in the identical image of the existing product or solution to address an identical or similar problem or situation. The replication is by way of the adoption of the existing product or solution or in parts, the form, idea and/or processes of the product or solution of the existing product or solution.
	Create	To hypothesise and generate completely anew, products or solutions or synthesise diverse existing knowledge in unconventional ways to create new products or solutions. A completely new product or solution will be arrived at through the creation form, idea and/or process that is significantly different, relevant and more advanced from existing product or solutions.
	Characterise	To analyse and break down the problem or situation to develop a product or solution. The product or solution may be arrived at through the adoption of an existing resource or by adapting the form, idea and/or process of an existing product or solution.
	Transfer	To develop a product or solution by borrowing from other resources of similar nature The transfer may be in the adaption of the entire existing product or solution from an unrelated field or in parts the form, idea and/or processes of the original from a related or unrelated field.
	Imitate	To model after an existing product or solution not in an identical manner to address a similar problem or situation The imitation may be an adaptation of the entire product or solution, or in parts, the form, idea and/or processes of the existing product or solution.

Section B



1. Look at the pyramid above. How would you compare your order of the 6 creative strategies to the one in the pyramid? Which one do you consider better, and why?

2. You may refer to the Supplementary Document for the “Taxonomic Framework for Creativity”. Do you think the framework appropriately reflects the various strategies of being creative? Please provide reasons.

3. Would you add/change anything to the framework? Why? Do you anticipate anything negative when using the framework? What are they?

You may want to comment on the (i) relevance, (ii) order of the strategies (iii) effectiveness and (iv) flexibility of the framework.

4. Nominate a lecturer (in UNMC) and a student (in UNMC) that you think are creative, and say why you think so.

5. Is a framework like this necessary and useful for the development of creativity and understanding the processes involved in creativity? Why and why not?

6. How would you use a framework like this?

7. Is this framework easy to understand? How can it be improved?

8. Is this framework user friendly? How can it be improved?

APPENDIX D
Interview Guide

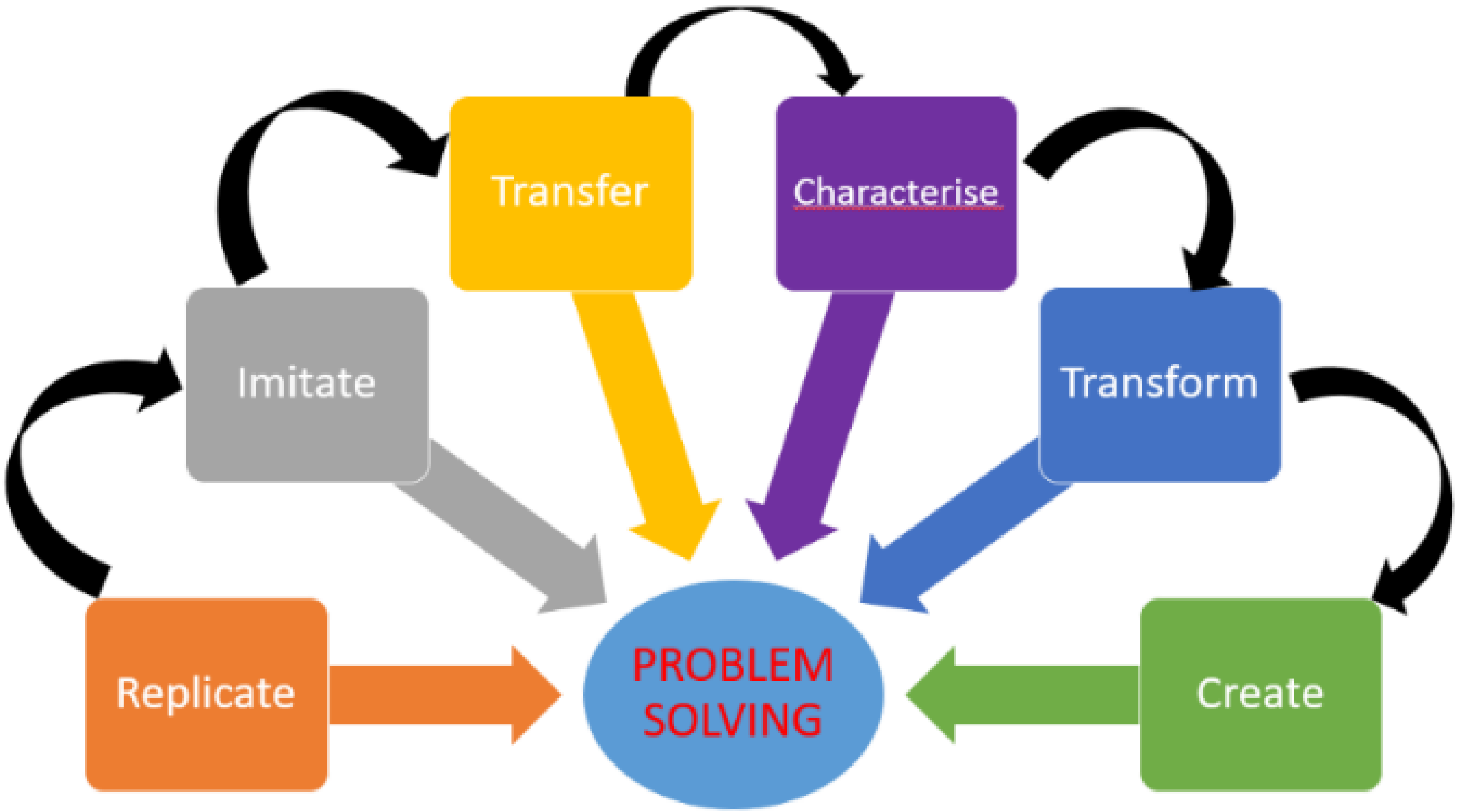
1. Is creativity an important characteristics or skill?
2. What is the main purpose of being creative or using creativity?
3. In your opinion, is creativity a natural characteristic or a learned skill?

   - Why do you think you are chosen as a creative lecturer?
   - How would you rate your own creativity on a scale of 1 to 10?
   - What criteria or features do you use to rate your creativity?

4. What criteria do you use to rate the creativity of your students/lecturers and others (including colleagues/peers)?
5. Would you like to further enhance your creativity? How?
6. (If they are talking about some activities that they do) How do you evaluate if it's creative or a creative activity? Is there a rationale? Is there a guideline?
7. Do you think a framework like this will be useful personally and for teaching and learning? What are the possible uses of the framework?
8. How would this framework be useful outside the classroom?
9. Based on the taxonomic framework, which types of the creative strategies are you engaged in more frequently?
10. Do you think that this framework and supporting material need to be further improved? How?
11. Would you use this?

APPENDIX E

Revised Taxonomic Framework for Creativity (For Interview) – Revised based on Phase II (Survey)



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Example

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Solution: Using surgery to remove the affected area of the organ

Explanation: The use of surgery has long existed, and therefore if this way is used to solve the problem (treat organ failure), there is very low innovation in the solution.

What is the outcome?

The solution can be a concept, process and/or product.

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The product or solution:

- addresses personal problems
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Explanation: Chemotherapy uses Nitrogen Mustard gas as an anti-cancer drug. Nitrogen Mustard gas was initially used to make weapons for wars. The use of Nitrogen Mustard is transferred to the medical field to treat organ failure or cancer.

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What is it?

To develop a product or solution through the characterisation of the problem.

The product or solution may be arrived at through:

(i) **the adoption of an existing resource or**

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Characterise

Example

Problem: Organ failure

Solution: Using Targeted Therapy to control the growth of cancer cells that cause organ failure.

Explanation: Targeted Therapy is developed to help stop the cancer cells from growing. This solution is a “characterisation” because it is developed after analysing that chemotherapy will also kill the healthy cells, and this leads to side effects like hair loss, blood loss etc.

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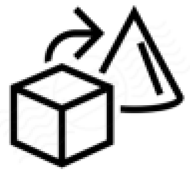

Transform

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What is the outcome?

The solution can be a concept, process and/or product.

What is the impact?

The product or solution:

- addresses global problems or situations.
- solves problems by building upon existing knowledge or solutions.
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Explanation: Organ transplant is a synthesis of different medical solution features. Among these include the features of a surgery and immunotherapy (immunosuppressive therapy – to reduce the strengths of the immune system so that the body is less likely to reject the transplanted organ).

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The solution can be a concept, process and/or product.

What is the impact?

The product or solution:

- addresses global problems or situations.
- solves problems using revolutionary ideas and methods.
- is original or novel.

Example

Problem: Organ failure

Solution: Using "cloning" to treat organ failure

Explanation: "Cloning" is a "creation" because it is unconventional – it breaks the conventional idea that organ failure can only be treated either by removing the affected organ areas, killing or controlling the growth of bad cells. "Cloning" brings a new solution by producing/cloning identical human cells or even the whole organ to replace the failed organ.

Check yourself:

- ❑ I know the strengths I have to solve this problem.
- ❑ I know the limitations I need to overcome in solving this problem.

- ❑ I know the problem that needs to be solved.
- ❑ I know the underlying causes of the problem.
- ❑ I know the steps to solve the problem.
- ❑ I know the knowledge I need to better understand the problem.

- ❑ I know why I want to use this strategy to solve this problem.
- ❑ I know the existing products or solutions that I can adopt or adapt.

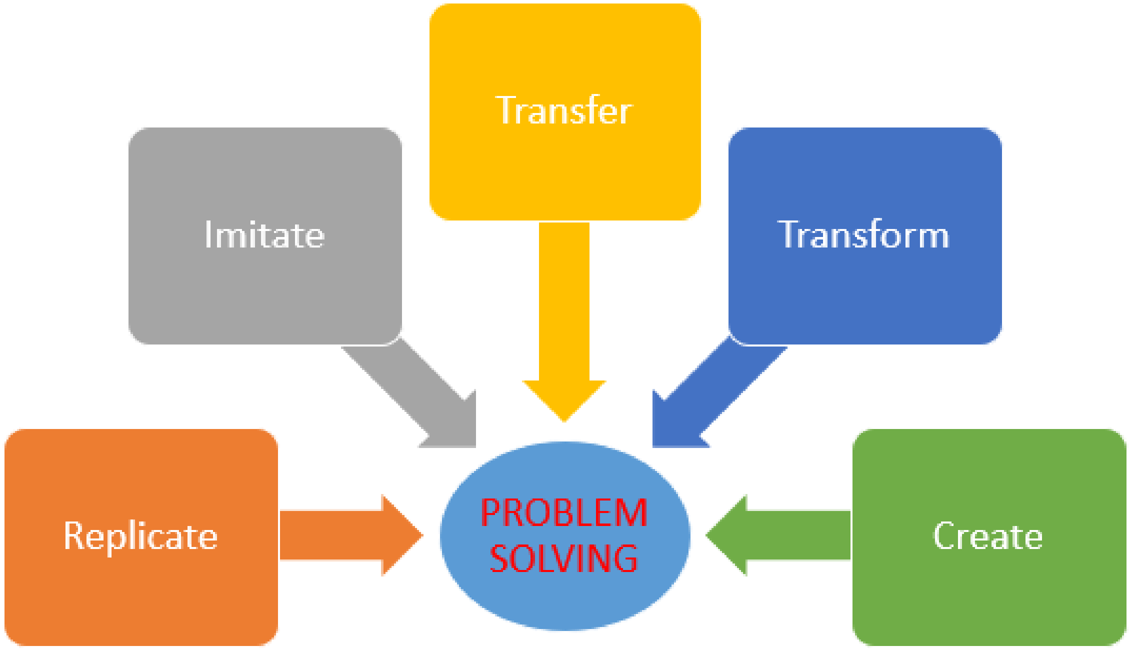
- ❑ I can judge if the way I play with the idea can solve the problem.
- ❑ I can judge if the product or solution I produce can solve the problem.

- ❑ I am motivated to solve this problem.
- ❑ I am open to new possibilities.
- ❑ I try to produce many solutions without worrying about right or wrong.
- ❑ I try to use whatever resources available to me.

APPENDIX F

Revised Taxonomic Framework for Creativity (For Problem-Solving Task) – Revised based on Phase I & II (Survey & Interview)

Taxonomic Framework for Creativity



Replicate

What is it?

To reproduce in the identical image of an existing idea or solution to address an identical or similar problem or situation.

The replication is by way of the:

I. adoption of an existing concept, process and/or product, or
II. in parts, the concept and/or process of a product

What is the outcome?

The solution can be a concept, process and/or product.

What is the impact?

The product or solution:

- addresses personal problems
- is valuable to the problem solver

Example

Problem:
Information or knowledge captured in wall painting cannot be transported.

Solution:
Painted/carved information or knowledge that is captured in wall painting onto a slate so that the written images can be transported.

Check yourself:

- ❑ I know the strengths I have to solve this problem.
- ❑ I know the limitations I need to overcome in solving this problem.

- ❑ I know the problem that needs to be solved.
- ❑ I know the underlying causes of the problem.
- ❑ I know the steps to solve the problem.
- ❑ I know the knowledge I need to better understand the problem.

- ❑ I know why I want to use this strategy to solve this problem.
- ❑ I know the existing products or solutions that I can adopt or adapt.

- ❑ I can judge if the way I play with the idea can solve the problem.
- ❑ I can judge if the product or solution I produce can solve the problem.

- ❑ I am motivated to solve this problem.
- ❑ I am open to new possibilities.
- ❑ I try to produce many solutions without worrying about right or wrong.
- ❑ I try to use whatever resources available to me.

What is it?

To model after an existing idea or solution not in an identical manner to address a similar problem or situation.

The imitation may be an adaptation of:

I. the entire concept, process and/or product, or
II. in parts, the concept and/or process of a product.

Imitate

What is the outcome?

The solution can be a concept, process and/or product.

What is the impact?

The product or solution:

- addresses problems or situations related to the immediate context.
- is valuable to the problem solver.
- solves common day-to-day problems.

Example

Problem:

- The slates are too heavy to be transported.
- Very limited information can be captured in a slate.

Solution:

- Putting information or knowledge on paper so that it is light to carry around and more information can be contained.
- Use words instead of images to convey meaning

❑ I know the strengths I have to solve this problem.
❑ I know the limitations I need to overcome in solving this problem.

❑ I know the problem that needs to be solved.
❑ I know the underlying causes of the problem.
❑ I know the steps to solve the problem.
❑ I know the knowledge I need to better understand the problem.

❑ I know why I want to use this strategy to solve this problem.
❑ I know the existing products or solutions that I can adopt or adapt.

❑ I can judge if the way I play with the idea can solve the problem.
❑ I can judge if the product or solution I produce can solve the problem.

❑ I am motivated to solve this problem.
❑ I am open to new possibilities.
❑ I try to produce many solutions without worrying about right or wrong.
❑ I try to use whatever resources available to me.

Transfer

What is it?

To develop an idea or solution by borrowing from other resources of similar or different nature.

The transfer may be in the adaption of:

I. the entire existing idea or solution from an unrelated field or

II. use in parts, the concept and/or process of a product from a related or unrelated field.

What is the outcome?

The solution can be a concept, process and/or product.

What is the impact?

The product or solution:

- addresses problems or situations related to a wider community.
- solves shared problems at a community level.

Example

Problem:
The information captured in a book/paper cannot be reached far.

Solution:
Mass production – printing and publication.

- ❑ I know the strengths I have to solve this problem.
- ❑ I know the limitations I need to overcome in solving this problem.

- ❑ I know the problem that needs to be solved.
- ❑ I know the underlying causes of the problem.
- ❑ I know the steps to solve the problem.
- ❑ I know the knowledge I need to better understand the problem.

- ❑ I know why I want to use this strategy to solve this problem.
- ❑ I know the existing products or solutions that I can adopt or adapt.

- ❑ I can judge if the way I play with the idea can solve the problem.
- ❑ I can judge if the product or solution I produce can solve the problem.

- ❑ I am motivated to solve this problem.
- ❑ I am open to new possibilities.
- ❑ I try to produce many solutions without worrying about right or wrong.
- ❑ I try to use whatever resources available to me.

Transform

What is it?

To synthesise features from two or more ideas or solutions to develop an advanced solution to address a problem or situation in different ways.

The idea or solution may be arrived at through the:

I. manipulation and
II. reengineering of the concepts and/or processes of different products.

What is the outcome?

The solution can be a concept, process and/or product.

What is the impact?

The product or solution:

- addresses global problems or situations.
- solves problems by building upon existing knowledge or solutions.
- may be original or novel.

Example

Problem:
Information captured in book/paper is not readily mobile or transferable

Solution:
Using word processor computers and the Internet to share and communicate information or knowledge.

- ❑ I know the strengths I have to solve this problem.
- ❑ I know the limitations I need to overcome in solving this problem.

- ❑ I know the problem that needs to be solved.
- ❑ I know the underlying causes of the problem.
- ❑ I know the steps to solve the problem.
- ❑ I know the knowledge I need to better understand the problem.

- ❑ I know why I want to use this strategy to solve this problem.
- ❑ I know the existing products or solutions that I can adopt or adapt.

- ❑ I can judge if the way I play with the idea can solve the problem.
- ❑ I can judge if the product or solution I produce can solve the problem.

- ❑ I am motivated to solve this problem.
- ❑ I am open to new possibilities.
- ❑ I try to produce many solutions without worrying about right or wrong.
- ❑ I try to use whatever resources available to me.

Create

What is it?

To generate completely anew ideas or solutions or synthesise diverse existing knowledge in unconventional ways to create new solutions.

A new idea or solution will be arrived at through the creation of concepts, processes and/or products that is significantly different, relevant and more advanced from the existing ideas or solutions.

What is the outcome?

The solution can be a concept, process and/or product.

What is the impact?

The product or solution:

- addresses global problems or situations.
- solves problems using revolutionary ideas and methods.
- is original or novel.

Example

Problem:
information stored in a hard drive may disappear or get corrupted

Solution:
Using Cloud system to store, share and communicate information or knowledge.

- ❑ I know the strengths I have to solve this problem.
- ❑ I know the limitations I need to overcome in solving this problem.

- ❑ I know the problem that needs to be solved.
- ❑ I know the underlying causes of the problem.
- ❑ I know the steps to solve the problem.
- ❑ I know the knowledge I need to better understand the problem.

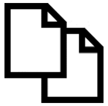
- ❑ I know why I want to use this strategy to solve this problem.
- ❑ I know the existing products or solutions that I can adopt or adapt.

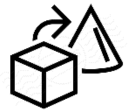
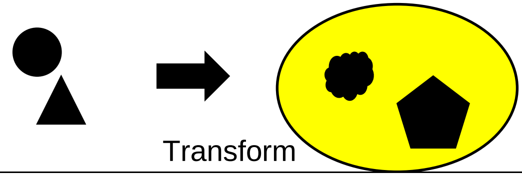
- ❑ I can judge if the way I play with the idea can solve the problem.
- ❑ I can judge if the product or solution I produce can solve the problem.

- ❑ I am motivated to solve this problem.
- ❑ I am open to new possibilities.
- ❑ I try to produce many solutions without worrying about right or wrong.
- ❑ I try to use whatever resources available to me.

APPENDIX G

Infographic Summary (presented to the Students during Problem-Solving Task together with the Taxonomic Framework in APPENDIX F)

Strategies	What is it?	Key Concepts	Example
Replicate 	To reproduce in the identical image of the existing product or solution to address an identical or similar problem or situation. The replication is by way of the: (iii) adoption of an existing product or solution, or (iv) in parts, the form, idea and/or processes of the product or solution.	▪ If an idea/product/solution is replicated, the outcome will generally remain unchanged.	**Problem:** Information or knowledge captured in wall painting cannot be transported. **Solution:** Paint/carve information or knowledge that is captured in wall painting onto a the slates so that the written pieces can be transported.
Imitate 	To model after an existing product or solution not in an identical manner to address a similar problem or situation The imitation may be an adaptation of: (iii) the entire product or solution, or (iv) in parts, the form, idea and/or processes of the existing product or solution.	▪ If an idea/product/solution is replicated, the outcome will be slightly changed.	**Problem:** ▪ The slates are too heavy to be transported. ▪ Very limited information can be captured in a slate. **Solution:** ▪ Putting information or knowledge on paper so that it is light to carry around and more information can be contained. ▪ Instead of painting, imitate the symbols to create words to communicate.
Transfer 	To develop a product or solution by borrowing from other resources of similar nature The transfer may be in the adaption of: (iii) the entire existing product or solution from an unrelated field or (iv) in parts the form, idea and/or processes of the original from a related or unrelated field.	▪ When a product or solution is transferred, its function does not change when it is applied in a similar or different context.	**Problem:** The information captured in a book/paper cannot be reached far. **Solution:** Mass production – printing and publication.
Transform			**Problem:**

	To <u>synthesise features</u> from two or more products or solutions to develop an <u>advanced</u> product or solution to address a <u>new problem</u> or situation. The product or solution may be arrived at through the: (iii) manipulation and (iv) reengineering of the form, idea and/or process of existing products or solutions.	▪ When a product or solution is transformed, its function changes when it is applied in a similar or different context. 	The information captured in a book/paper cannot be reached far. **Solution:** Using Word processor with Internet to share and communicate information or knowledge.
Create 	To <u>hypothesise and generate</u> completely <u>anew</u>, products or solutions. To <u>synthesise</u> diverse existing knowledge in <u>unconventional</u> ways to create new products or solutions. A completely new product or solution will be arrived at through the creation of the form, idea and/or process that is significantly different, relevant and more advanced from existing product or solutions.	▪ The process involved is unconventional. ▪ The outcome is revolutionary.	**Problem:** The information stored in a hard drive may disappear. **Solution:** Using Cloud system to store, share and communicate information or knowledge.

APPENDIX H
Finalised Taxonomic Framework for Creativity

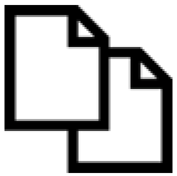
The **Taxonomic Framework for Creativity** is for educators and students to teach, learn and describe creativity. In this taxonomic framework, there are five creative strategies that can support you to be creative in problem solving. These strategies are *Replicate, Imitate*, *Transfer* and *Transform*. These strategies have been arranged to from the least creative to the most creative one. This means that creativity in problem solving can exist in a continuum. Some problems may need to be solved using a more creative strategy, some problems may not need one that is creative. You as the problem solver will decide the suitability of the strategy depending on the problem. It is important to note that this taxonomic framework does NOT prescribe a step-by-step model that states creativity must begin from *Replicate* followed by *Imitate* through to *Create*.

Strategies alone do not solve the problem. To facilitate your use of strategies, the “User Reflection Checklist” can help you to prepare you for employing these strategies. It guides you to find out if you have gained an understanding of yourself, the problem, how to solve the problem, the strategies, your intuition, your statement of mind and the environment you are in. In other words, it aims to help you optimise the opportunities for creativity.

For **educators**, you can use the framework to teach creativity and plan curriculum and lesson design across curriculum. You can adapt the taxonomic framework according to the subject you are teaching, the students and your context based on your objectives. You can integrate it with any other frameworks that you are currently using. If you are using Bloom’s Taxonomy, the five strategies in the framework can assist you in planning learning outcomes for the “Create” level in Bloom’s Taxonomy.

For **students**, you can use the framework for your learning and self-assessment. You can use it for your assignments, projects, your extra-curricular and self-enrichment activities. This framework is applicable for both academic and non-academic creative endeavours.

*This taxonomic framework is flexible for adaptability.



Replicate

What is it?

To reproduce in the identical image of an existing idea or solution to address an identical or similar problem or situation.

The replication is by way of the:

I. adoption of an existing concept, process and/or product, or
II. in parts, the concept and/or process of a product

What is the outcome?

The solution can be a concept, process and/or product.

What is the impact?

You may appraise the novelty, usefulness, and the ethicality of the solution. You may also use other criteria.

The solution is relevant to:

I. the creator (personal)
II. the creator's immediate context (friends, people the creator works with)
III. a wider community (this could be a professional community or organisation)
IV. a society
V. the global community

Example

Problem:
Information or knowledge captured in wall painting cannot be transported.

Solution:
Painted/carved information or knowledge that is captured in wall painting onto a slate so that the written images can be transported.

Imitate

What is it?

To model after an existing idea or solution not in an identical manner to address a similar problem or situation.

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What is the outcome?

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V. the global community

Example

Problem:

- The slates are too heavy to be transported.
- Very limited information can be captured in a slate.

Solution:

- Putting information or knowledge on paper so that it is light to carry around and more information can be contained.
- Use words instead of images to convey meaning

Transfer

What is it?

To develop an idea or solution by borrowing from other resources of similar or different nature.

The transfer may be in the adaption of:

I. the entire existing idea or solution from an unrelated field or
II. use in parts, the concept and/or process of a product from a related or unrelated field.

What is the outcome?

The solution can be a concept, process and/or product.

What is the impact?

You may appraise the novelty, usefulness, and the ethicality of the solution. You may also use other criteria.

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III. a wider community (this could be a professional community or organisation)
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V. the global community

Example

Problem:
The information captured in a book/paper cannot be reached far.

Solution:
Mass production – printing and publication.

Transform

What is it?

To synthesise features from two or more ideas or solutions to develop an advanced solution to address a problem or situation in different ways.

The idea or solution may be arrived at through the:

I. manipulation and
II. reengineering of the concepts and/or processes of different products.

What is the outcome?

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What is the impact?

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The solution is relevant to:

I. the creator (personal)
II. the creator's immediate context (friends, people the creator works with)
III. a wider community (this could be a professional community or organisation)
IV. a society
V. the global community

Example

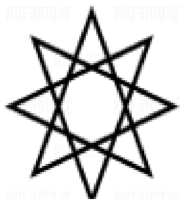
Problem:
Information captured in book/paper is not readily mobile or transferable

Solution:
Using word processor computers and the Internet to share and communicate information or knowledge.

What is it?

To generate completely anew ideas or solutions or synthesise diverse existing knowledge in unconventional ways to create new solutions.

A new idea or solution will be arrived at through the creation of concepts, processes and/or products that is significantly different, relevant and more advanced from the existing ideas or solutions.



Create

What is the outcome?

The solution can be a concept, process and/or product.

Example

Problem:
information stored in a hard drive may disappear or get corrupted

Solution:
Using Cloud system to store, share and communicate information or knowledge.

What is the impact?

You may appraise the novelty, usefulness, and the ethicality of the solution. You may also use other criteria.

The solution is relevant to:

I. the creator (personal)
II. the creator's immediate context (friends, people the creator works with)
III. a wider community (this could be a professional community or organisation)
IV. a society
V. the global community

Taxonomic Framework for Creativity: User Reflection Checklist

(a) Understanding self:
- ❑ I know the strengths and abilities I have to solve this problem.
- ❑ I know how to overcome my limitations in solving this problem.

(b) Understanding the problem:
- ❑ I know the problem that needs to be solved.
- ❑ I know the underlying causes of the problem.

(c) Understanding how to solve the problem:
- ❑ I know the steps to solve the problem.
- ❑ I know the knowledge I need in order to better understand the problem.
- ❑ I know the knowledge and skills I need to solve the problem.

(d) Understanding the strategies:
- ❑ I know why I want to use this strategy to solve this problem.
- ❑ For the existing solution I want to adopt or adapt, I know its underlying concepts and/or processes.
- ❑ I know the features of the solution that I want to adopt or adapt.

(e) Following intuition:
- ❑ I can judge if the strategy that I want to use is appropriate to solve the problem.
- ❑ I can judge if the way I play with the idea can solve the problem.
- ❑ I can judge if the solution I produce can solve the problem.

(f) Understanding the state of mind:
- ❑ I feel strongly about the need to solve this problem.
- ❑ I keep an open mind for new possibilities when working alone and with others.
- ❑ I try to produce many solutions without worrying about right or wrong.

(g) Understanding the environment:
- ❑ I try to use whatever resources available to me.
- ❑ I overcome the lack of resources in my context.

*These resources could be people you work with, the availability of facilities, financial support, freedom and time. You may have other resources that are relevant to your own context.

APPENDIX I

Participant Information Sheet and A Sample of Signed Consent Form

(Survey)

PARTICIPANT INFORMATION

Faculty of Arts and Social Sciences
School of Education

Project Title: Developing a Taxonomic Framework for Creativity: A Design for Higher Education

Researcher: Chai Xun Yu — Email: kabx6cxy@nottingham.edu.my

Supervisor : 1. Dr. Anne Goodith White — Email: anne.goodithwhite@ucd.ie
2. Dr. Wong Tze Peng — Email: tzepeng.wong@nottingham.edu.my

Ethics Approval Reference Number: FASS2018-0006/SoEdu/CXY18025137

This is an invitation to take part in a research study about developing a taxonomic framework for creativity for the higher education context. This information is designed to tell you what it will involve.

Your participation is voluntary, and you may change your mind about being involved, or decline to answer a particular question without giving a reason. You are free to withdraw at any point before or during the study. For anonymous questionnaires, once you have finished the questionnaire and submitted your answers it is not possible to withdraw the data.

What is the project about? This study aims at developing a taxonomic framework for creativity that is hoped to be able to help higher education educators and students to use identify, develop and use different aspects of creativity.

Who is being asked to take part, and why? This study involves higher education educators and students from various disciplines because it aims to develop a generic taxonomic framework that can be applied across disciplines. It is entirely up to you to decide whether or not to take part in the study. If you do decide to take part, you will be given this information sheet to keep and asked to sign a consent form. Even if you decide to take part, you are still free to withdraw at any time and without giving a reason.

What will I be asked to do? Participants of this study will be required to complete a survey, which takes about 30 minutes. The survey contains 10 questions, which invite you to share your perceptions about creativity and your opinions about the taxonomic framework shared with you in the survey

Will the research be of any personal benefit to me? The taxonomic framework for creativity developed from this study is hoped to be able to help higher education educators translate elements of creativity into pedagogies, to assist them to teach creatively and teach for creativity.

What will happen to the information I provide? The data I collect will be treated confidentially, and only my supervisors and I will have access to the raw data. In accordance with the current Data Protection Act, all information collected while carrying out the study will be stored on a database which is password protected and strictly confidential. The data resulting from the problem-solving tasks and interviews will be kept in a secure and confidential location. Your name will not appear on any database or any information which is subsequently published. Instead, a number or a pseudonym will be used as an identifier on all data associated with you. The master copy of the names associated with each number will be kept in a secure and confidential location. Any information about you which leaves the research unit will have your name and address removed so that you cannot be recognised from it.

What will you do with the data? This data will be used for the researcher's thesis.

If you have any questions or concern, please do not hesitate to seek clarification. We can be contacted before and after your participation at the above address.

THANK YOU FOR YOUR PARTICIPATION

If you have any queries or complaints about this study, please contact the student's supervisor in the first instance. If this does not resolve the query to your satisfaction, please write to the Administrator to FASS Research Ethics Committee (Norhidayah.MohdNoor@nottingham.edu.my, 03-8924 8742) who will pass your query to the Chair of the Committee

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

Mei 57

PARTICIPANT CONSENT

Faculty of Arts and Social Sciences
School of Education

Project Title: Developing a Taxonomic Framework for Creativity: A Design for Higher Education

Researcher: Chai Xun Yu — Email: kabx6cxy@nottingham.edu.my

Supervisor : 1. Dr. Anne Goodith White — Email: anne.goodithwhite@ucd.ie
2. Dr. Wong Tze Peng — Email: tzepeng.wont@nottingham.edu.my

Ethics Approval Reference Number: FASS2018-0006/SoEdu/CXY18025137

• Have you read and understood the Participant Information?	YES/NO
• I agree to take part in the survey.	YES/NO
• Do you know how to contact the researcher if you have questions about this study?	YES/NO
• Do you understand that you are free to withdraw from the study without giving a reason?	YES/NO
• Do you understand that for anonymous survey studies, once you have completed the study and submitted your survey, the data cannot be withdrawn?	YES/NO
• Do you give permission for your data from this study to be shared with other researchers in the future provided that your anonymity is protected?	YES/NO
• Do you understand that non-identifiable data from this study might be used in academic research reports or publications?	YES/NO

Signature of the Participant .... Date: 3/4/18

Name (in block capit[redacted]

This consent form will be detached from the completed questionnaire and stored separately. Your answers will not be identifiable.

FASS2018-0006/SoEdu/CXY18025137

3

Participant Information Sheet and A Sample of Signed Consent Form

(Interview)

The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

PARTICIPANT INFORMATION

Faculty of Arts and Social Sciences
School of Education

Project Title: Developing a Taxonomic Framework for Creativity: A Design for Higher Education

Researcher: Chai Xun Yu Email: kabx6cxy@nottingham.edu.my

Supervisors : 1. Dr. Anne Goodith White Email: anne.goodithwhite@ucd.ie
2. Dr. Wong Tze Peng Email: tzepeng.wong@nottingham.edu.my

Ethics Approval Reference Number: FASS2018-0006/SoEdu/CXY18025137

This is an invitation to take part in a research study about developing a taxonomic framework for creativity for the higher education context. This information is designed to tell you what it will involve.

Your participation is voluntary, and you may change your mind about being involved, or decline to answer a particular question or stop the recording at any time, and without giving a reason. You are free to withdraw at any point before or during the study.

What is the project about? This study aims at developing a taxonomic framework for creativity that will help educators teach creatively and develop student creativity. With this aim, this study will (i) identify the components that make up the taxonomic framework for creativity, (ii) assess if the framework is useful by looking at how higher education teachers and students demonstrate creativity in problem-solving tasks, and (iii) find out how the framework can be improved.

Who is being asked to take part, and why? This study involves higher education educators and students from various disciplines because it aims to develop a generic taxonomic framework that helps higher education educators teach creatively and develop student creativity. It is entirely up to you to decide whether or not to take part in the study. If you do decide to take part, you will be given this information sheet to keep and asked to sign a consent form. Even if you decide to take part, you are still free to withdraw at any time and without giving a reason.

What will I be asked to do? Participants of this study will take part in an interview that will take about 20 to 30 minutes.

Will the research be of any personal benefit to me? The taxonomic framework for creativity developed from this study is hoped to be able to help higher education educators to translate elements of creativity into pedagogies, so as to help them teach creatively and teach for creativity.

FASS2018-0006/SoEdu/CXY18025137

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

What will happen to the information I provide? The data we collect will be treated confidentially, and only my supervisor and I will have access to the raw data. In accordance with the current Data Protection Act, all information collected while carrying out the study will be stored on a database which is password protected and strictly confidential. The data resulting from the problem-solving tasks and interviews will be kept in a secure and confidential location. Your name will not appear on any database or any information which is subsequently published. Instead, a number or a pseudonym will be used as an identifier on all data associated with you. The master copy of the names associated with each number will be kept in a secure and confidential location. Any information about you which leaves the research unit will have your name and address removed so that you cannot be recognised from it.

What will you do with the data? This data will be used for the researcher's thesis.

If you have any questions or concerns, please don't hesitate to seek clarification. We can be contacted before and after your participation at the above address.

THANK YOU FOR YOUR PARTICIPATION

If you have any queries or complaints about this study, please contact the student's supervisor in the first instance. If this does not resolve the query to your satisfaction, please write to the Administrator to FASS Research Ethics Committee (Norhidayah.MohdNoor@nottingham.edu.my, 03-8924 8742) who will pass your query to the Chair of the Committee

FASS2018-0006/SoEdu/CXY18025137

The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

PARTICIPANT CONSENT

Faculty of Arts and Social Sciences
School of Education

Project Title: Developing a Taxonomic Framework for Creativity: A Design for Higher Education

Researcher: Chai Xun Yu — Email: kabx6cxy@nottingham.edu.my

Supervisors : 1. Dr. Anne Goodith White — Email: anne.goodithwhite@ucd.ie
2. Dr. Wong Tze Peng — Email: tzepeng.wong@nottingham.edu.my

Ethics Approval Reference Number: FASS2018-0006/SoEdu/CXY18025137

• Have you read and understood the Participant Information?	YES/NO
• I agree to take part in an interview that will be recorded.	YES/NO
• Do you know how to contact the researcher if you have questions about this study?	YES/NO
• Do you understand that you are free to withdraw from the study without giving a reason?	YES/NO
• Do you understand that once you have been interviewed it may not be technically possible to withdraw your data unless requested within *24 hours*?	YES/NO
• Do you give permission for your data from this study to be shared with other researchers in the future provided that your anonymity is protected?	YES/NO
• Do you understand that non-identifiable data from this study might be used in academic research reports or publications?	YES/NO

Signature of the Participant .... Date: 11/03/2019

Name (in block capitals) [redacted]

FASS2018-0006/SoEdu/CXY18025137

Participant Information Sheet and A Sample of Signed Consent Form

(Problem-Solving Task)

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

PARTICIPANT INFORMATION

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School of Education

Project Title: Developing a Taxonomic Framework for Creativity: A Design for Higher Education

Researcher:	Chai Xun Yu	Email: kabx6cxy@nottingham.edu.my
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This is an invitation to take part in a research study about developing a taxonomic framework for creativity for the higher education context. This information is designed to tell you what it will involve.

Your participation is voluntary, and you may change your mind about being involved, or decline to answer a particular question without giving a reason. You are free to withdraw at any point before or during the study. For anonymous questionnaires, once you have finished the questionnaire and submitted your answers it is not possible to withdraw the data.

What is the project about? This study aims at developing a taxonomic framework for creativity that is hoped to be able to help higher education educators and students to use identify, develop and use different aspects of creativity.

Who is being asked to take part, and why? This study involves higher education educators and students from various disciplines because it aims to develop a generic taxonomic framework that can be applied across disciplines. It is entirely up to you to decide whether or not to take part in the study. If you do decide to take part, you will be given this information sheet to keep and asked to sign a consent form. Even if you decide to take part, you are still free to withdraw at any time and without giving a reason.

What will I be asked to do? Participants of this study will be required to complete a task for two rounds. During the first round, you will first be invited to complete a task, which will take about 20 minutes. It will then be followed up by an interview, which will take about 30 minutes. This process will be repeated during the second round, with a guidance of a framework. Between the first and the second round, you will be given a break for 30 minutes, depending on your needs. Your engagement and interview in the task will be videotaped.

Will the research be of any personal benefit to me? The taxonomic framework for creativity developed from this study is hoped to be able to help higher education educators translate elements of creativity into pedagogies, to assist them to teach creatively and teach for creativity.

What will happen to the information I provide? The data I collect will be treated confidentially, and only my supervisors and I will have access to the raw data. In accordance with the current Data Protection Act, all information collected while carrying out the study will be stored on a database which is password protected and strictly confidential. The data resulting from the problem-solving tasks and interviews will be kept in a secure and confidential location. Your name will not appear on any database or any information which is subsequently published. Instead, a number or a pseudonym will be used as an identifier on all data associated with you. The master copy of the names associated with each number will be kept in a secure and confidential location. Any information about you which leaves the research unit will have your name and address removed so that you cannot be recognised from it.

What will you do with the data? This data will be used for the researcher's thesis.

If you have any questions or concern, please do not hesitate to seek clarification. We can be contacted before and after your participation at the above address.

THANK YOU FOR YOUR PARTICIPATION

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PARTICIPANT CONSENT

Faculty of Arts and Social Sciences
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Researcher: Chai Xun Yu Email: kabx6cxy@nottingham.edu.my
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• Do you understand that non-identifiable data from this study might be used in academic research reports or publications?	YES/NO

Signature of the Participant .... Date: 21/3/19.

Name (in block capitals) [redacted]