A STUDY OF THE EXPERIENCES OF VOCATIONAL STUDENTS LEARNING FUNCTIONAL MATHEMATICS IN FURTHER EDUCATION COLLEGES

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Abstract

The education system in England has long been characterised by a distinct separation between academic and vocational pathways in the post-16 phase. Until recent policy changes this division coincided with the point at which compulsory education ended and mathematics became an optional subject for many students. Those who failed to attain the widely accepted minimum standard of a grade C in GCSE mathematics, however, were often strongly encouraged to undertake a course to improve their mathematical knowledge and skills. This study focuses on students aged 16-19 and examines the learning experience of those who take a functional mathematics course alongside their vocational programme, as either a recommended option or a requirement of internal college policy.

Research regarding the learning of mathematics for these students within the context of Further Education is limited. The study adopts a holistic view of the situation to explore the main factors that influence the student experience, with an emphasis on gaining insight and understanding of students' perceptions of their learning situation. Using a grounded theory approach with multiple methods, the research includes a series of case studies of seventeen student groups across three Further Education colleges, from which within-case and cross-case themes are identified.

The research findings show how the student experience of functional mathematics is affected by a complex network of inter-linking factors associated with both the organisation and the individual. Although organisational factors such as policies and systems sometimes place constraints on opportunities, social and cultural influences shape student values and perceptions of functional mathematics. There is strong influence from individual teachers through differing interpretations of the curriculum and pedagogical approaches but social structures and relationships within the classroom are also important to students. In addition, the legacy of students' prior experiences of learning mathematics has an effect on attitudes and emotions, despite the separation of space and time, indicating the significance of both cognitive and affective factors in this interaction of multiple influences.

Many students approach functional mathematics in college with prior experiences of disaffection and low attainment but the study shows how attitudes and understanding are transformed for some students within the college environment. Fundamental to these changes is the functional curriculum which, based on the application of mathematics rather than knowledge-acquisition, facilitates teaching approaches that present a new image of

mathematics as a useful ‘tool for life’. Using materials such as contextualised tasks to make meaningful links to student lives increases awareness of the relevance of mathematics, leading to greater engagement and understanding.

In the transition from school to college there is a marked discontinuity of curriculum and environment, accompanied by value-changes indicating a stronger orientation towards adult life and vocational employment. Students respond positively to functional mathematics lessons where these values are embraced. Academic-vocational divisions, such as differences in values, culture, curriculum and approaches to learning, are evident at multiple levels in colleges and these produce tensions in the student experience of functional mathematics. Some effective bridging is achieved through appropriate classroom practices but coherence requires a multi-level embedded approach involving college structures and departmental policies rather than simply the actions of individual teachers.

The research findings suggest that reversing trends of disaffection and failure with mathematics amongst students can be achieved in post-16 education but this is dependent on changes within the curriculum and learning situation. In the light of recent policy changes in England that will increase the numbers of post-16 students taking a mathematics course and the prioritisation of GCSE mathematics over alternative curricula, this study has much to contribute to understanding students’ perceptions of mathematics and the factors that influence their learning experience.

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Contents

Glossary

Adult basic skills	A generic term used to describe adult numeracy and literacy skills or basic mathematics and English for adults.
Adult Numeracy	A curriculum for adults defined by the Adult Numeracy core curriculum and the specifications for Adult Numeracy qualifications. The main points are summarized in Table 1.
Core skills	A set of skills identified as under-pinning vocational education before being more clearly defined as key skills. These are not related to the core skills in mathematics qualifications currently under development.
Functional mathematics	The functional mathematics curriculum, as defined by the guidance and specifications for the current functional mathematics qualifications. The main points are summarized in Table 1.
Further Education college	For this study the meaning adopted includes general Further Education colleges but excludes specialist and sixth-form colleges.
Further Education	All post-16 education outside the mainstream school system that is not higher education. The meaning has been largely defined by the 1988 Education Act and the term ‘further education’ will be used in reference to earlier, less clearly-defined, forms of post-compulsory education.
Key Skills	A curriculum defined by the Key Skills standards and specifications. The main points are summarized in Table 1. The term ‘key skills’ is used in reference to the earlier and less well-defined form of these skills.
Incorporation	The process through which colleges were released from local authority control to become self-governing bodies with corporate status.

Skills for Life	The set of skills defined by the curricula for Adult Numeracy, Adult Literacy and English for Speakers of Other Languages.
Vocational courses	Courses in which either the skills are learned for a specific trade or occupation, or students study a broader-based curriculum in preparation for range of occupations in a vocational area.
Vocational	A wide range of employment-related areas, professions or trades may be commonly referred to as vocational. In this study the meaning will be confined to the occupations, trades and general areas of employment for which Further Education colleges provide training, up to and including Level 3, rather than professions requiring higher level training.

Abbreviations

BTEC	Business and Technology Education Council
CV	Curriculum Vitae
GCSE	General Certificate of Secondary Education
GNVQ	General National Vocational Qualification
NVQ	National Vocational Qualification
Ofsted	Office for Standards in Education
QCA	Qualification and Curriculum Authority
VRQ	Vocationally Related Qualification

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Chapter 1: Introduction

This study arises from a situation within Further Education that is particularly relevant to current mathematics education policy and practice in England but is also strongly related to my own involvement with this sector over the last 25 years. As a mathematics teacher in a Further Education college and later in the role of a college manager, my experiences provide a personal background from which the research question arises but also contribute significantly to the perspective taken.

In this introductory section I will firstly describe some of the current policy and recent developments that frame the study, before using two personal encounters with the teaching of mathematics to vocational students that will illustrate some of the aspects of relevance for the research. These will be used as a basis for a further description of the problem, the potential issues for consideration, my personal perspective for the research and the proposed focus of the study.

1.1 The research background

Concerns about the current levels of attainment of young adults in Britain with mathematics have been highlighted by poor performances in international comparisons and an apparent decline in standards (OECD, 2010). The implication that our education system is not producing the outcomes expected and that mathematics teaching is, in some way, inadequate has led to some strong political interest. Efforts to address the situation have tended to focus on these international comparisons but whether educational practices from other nations hold the key to improvement is arguable, since this approach overlooks cultural and contextual considerations that may affect the implementation and the effects of any reform.

One of the prime concerns for some time has been to increase the mathematical competence of post-16 students in preparation for mathematics or science-based studies at degree level (Savage & Hawkes, 2000) but less attention seems to have been paid to those who fail to achieve the widely accepted minimum standard of a grade C in GCSE mathematics at age 16. The current data available suggests that approximately 37% of the 2012/13 student cohort failed to achieve this standard (DfE, 2014) although others have previously estimated the figure at almost 50% (Hodgen & Marks, 2013). In view of the level of need this appears to be a significant but neglected area for improvement in post-16 education. Achievement in mathematics is important to the individual, not just because of the role it takes in controlling access to higher level study but because of a wider 'gatekeeping' position in society (Volmink, 1994). There is research evidence that low attainment on leaving school may be linked to future income (Ananiadou, Jenkins, & Wolf, 2004; Parsons & Bynner, 2005), and that poor numeracy skills are passed across generations (Bynner & Parsons, 2006) suggesting that the economic and social implications for individuals are significant. In a society where the majority feel alienated from mathematics and the subject is seen as a discriminator that attributes power to those with high achievement (Volmink, 1994) then widening access to a meaningful and successful mathematical experience is important. For students with low attainment at GCSE, progress with mathematics may be crucial to the quality of their future lives and their place in society. The apparent neglect of this area in research studies can only contribute to a cycle of poor achievement, linked to economic and social disadvantage.

Many of the students who fail to achieve a grade C in GCSE mathematics move into Further Education colleges to pursue vocational courses at different levels in post-16 education since they fail to meet the entry requirements for A-level study in school. At the time this study commenced, these students might be expected to take some steps to improve their mathematics but there was some flexibility for choices to be made between a GCSE mathematics resit and a functional mathematics course. A government requirement for students to take at least one functional skill meant that some students might take Information and Communications Technology (ICT) or English in preference to mathematics. In practice, many students could postpone improving their mathematics whilst concentrating on a different functional skill. Access to improvement in mathematics was, therefore, sometimes constrained by college policies as a result of attempts to respond to government requirements, funding levels and the college resources available. The effects of these variations in college policies and practices seems to have received limited interest from researchers or policy-makers but the potential impact on progress with mathematics for individual students in post-16 education would appear to be significant.

Recent considerations of the quality of provision in vocational education have been dominated by the Wolf report (2011) and the government response to this review. Although focussed on vocational qualifications, this report suggested that the mathematics skills of vocational students were inadequate and the qualifications in use at the time (Key Skills and the functional skills pilot qualifications) were inappropriate. Functional mathematics was dismissed as “conceptually incoherent” (Wolf, 2011, p.172) whilst GCSE mathematics was positioned as the only mathematics qualification with a widely-recognised value (Wolf, 2011). The report recommended that all students in post-16 education should repeat the qualification in preference to other alternatives. During the period of my research study, the government accepted this recommendation and responded with a policy to prioritise the achievement of GCSE mathematics in post-16 education. By making mathematics compulsory for those without GCSE grade C and strongly recommending that students should repeat this qualification rather than taking an alternative such as functional mathematics, the climate changed. From September 2013, many more vocational students were required to take a mathematics course as part of their post-16 study programme and GCSE mathematics was the preferred qualification aim.

Alongside this significant change in curriculum, the phased extension of compulsory education to age 18 has also increased the number of post-16 students who are in the position of having to re-sit the GCSE mathematics examination, or at least pursue an alternative mathematics course as a step towards repeating the qualification. With plans to also implement a policy that requires all students to take mathematics in some form until age 18 and the development of a core mathematics qualification for those not studying the subject at A-level, then it appears that many more post-16 students on vocational courses may be required to study mathematics in the future.

Current concerns in the Further Education sector about these changes seem to have focussed on providing sufficient mathematics teachers to cope with the additional demand and the effects of these policies on students appear to be only a secondary consideration. Although the need to improve the mathematical skills of young adults is well-evidenced, the suitability of repeating the GCSE mathematics qualification for low-attaining students on a vocational pathway in Further Education may be questioned.

Furthermore, the failure of previous strategies to improve the skills of low-attaining post-16 students is apparent. For example, the Moser report (1999) exposed the low levels of numeracy within the adult population in Britain, showing that approximately one in four adults had difficulty calculating the change when buying three common items of shopping (Moser, 1999). The subsequent Skills for Life Strategy (DfEE, 2001) introduced widespread reforms to the teaching of adult numeracy through a new Adult Numeracy Curriculum, new subject specialist teaching qualifications, extensive professional development for in-service teachers and support materials for teachers. During this period new research was undertaken to identify effective teaching practices for adult literacy and numeracy (Eldred, 2005; C. Roberts et al., 2005) but ten years later the impact of this extensive campaign on adult numeracy standards was negligible. The number of adults achieving Level 1 or above showed no significant change but the numbers at Entry Level 3 or above actually decreased slightly, from 79% in 2003 to 76% in 2011 (BIS, 2011). The skills problem remained and an effective strategy for improvement had not been identified.

The learning experience for students on vocational courses, particularly younger students, 16-19 years, received some attention at this time but was overshadowed by a focus on mature adults. Although research into adult education may contribute some findings of relevance, the differences in life phase, values and experience mean that the needs of this age group cannot be equated with those of a mature adult. Similarly, differences in environment and purpose between school and vocational education suggest that effective teaching approaches from schools research cannot be automatically transferred into this contrasting context. Further Education, generally, seems to have been under-represented in research studies but the mathematical needs of young vocational students seem particularly neglected. This research aims to examine the experience of 16-19 year olds in Further Education as they undertake a functional mathematics course alongside their vocational training programme, thereby addressing an under-researched section of mathematics education that affects the attainment of an increasing number of post-16 students.

1.2 A personal perspective on mathematics for vocational students

My first encounter with a mathematics course for vocational students occurred after several years of teaching in secondary schools and followed from a speculative enquiry for part-time work in the local Further Education college. The prospect of teaching a module of mathematics and physics to Beauty Therapy students brought three questions into my mind that I wanted to discuss but seemed inappropriate to ask at the time:

- What is a Beauty Therapy student?
- Why do they need to learn mathematics?
- Why not just teach them GCSE mathematics?

My reflections on these questions and the assumptions implicit in their formation illustrate several aspects of my personal perspective at this time.

Having followed a traditional academic path through school and university, my contact with vocational or further education was minimal and courses such as Beauty Therapy were outside my personal experience. My questions suggest a view of the place of mathematics in education that assumed this was primarily an academic subject with qualifications such as GCSE mathematics holding a special value. Mathematics teaching in school had primarily been focussed on gaining academic qualifications with occasional opportunities to share a wider appreciation of the discipline with students. Neither of these reasons for teaching mathematics could be easily reconciled with this situation in which a trainee Beauty Therapist was considered to need a course in mathematics and physics. My questions betrayed an underlying assumption that mathematics was not relevant to Beauty Therapy. The reason for the course only became clearer through visits to the training salon where I began to understand the mathematical competencies that underpinned working practices in this situation. Although I could then communicate the relevance to the students, their reactions indicated they were still unconvinced.

My third question revealed a preference for teaching a curriculum that was familiar but also revealed a lack of understanding that other curricula might exist outside the accepted secondary curriculum. Teaching mathematics for vocational students was a new experience associated with a different purpose for mathematics that focussed on practical applications in specific occupationally-related situations and this was initially difficult to grasp. This prospect of teaching mathematics to Beauty Therapy students was a scenario that challenged my view of mathematics in education, unsettled my established values and caused some adjustments. At this time, my views may have shown some agreement with Wolf (2011) that GCSE mathematics was the only true qualification worth teaching to students but through further involvement with vocational students over the following years my perspective began to shift.

The second significant encounter concerned the teaching of a mathematics module to GNVQ Construction students. Few teaching resources were available because the course was new but the advice given was to relate mathematics to the vocational course where possible. Having learned from my previous work with Beauty Therapy students, I undertook some preparatory learning of my own about the construction industry prior to the first lesson. The turning point in my relationship with this all male group of low-attaining students, who were largely intending to become bricklayers, came when they realised my knowledge about the size and weight of bricks exceeded theirs. This simple demonstration of knowledge that related to their interests suddenly earned me the respect and co-operation that simply being a competent mathematician could not bring to this situation. Furthermore, my on-going use of scenarios in the context of the building industry seemed to engage students who had initially appeared reluctant to learn any mathematics.

The value of vocational knowledge and contextualised tasks in this particular environment was the key to engagement and respect. These students were preparing for employment in a construction trade and mathematics only seemed to have a useful place if it related to the aims of their vocational training. This meant a re-orientation of my own perspective on teaching mathematics towards the purposes of the construction course and the interests of the students. Although my assumption was that in the construction area the value and purpose of mathematics would be clear, these students did not make the same connections without some assistance. They approached the lessons with negative attitudes but presenting the subject in way that made connections to their vocational area seemed to have some positive effects. Clear communication of mathematical concepts and processes was important but the positioning of the mathematics course within the surrounding vocational learning environment seemed to be crucial. For this vocational course, teaching mathematics became a much broader, creative and situation-specific activity than teaching a familiar curriculum in traditional manner.

1.3 The research perspective and focus

These two key encounters illustrate how my perspective on mathematics teaching for students on vocational courses was influenced by personal experience and highlighted the need to consider the relationship between “mathematics as a discipline, mathematics as a school subject and mathematics as a part of people’s lives” (Greer & Mukhopadhyay, 2003, p.3). The purposes and meaning of mathematics for a mathematician, for education and for life raise issues for educators and concerns about the perceived gap between classroom mathematics and life experiences (Greer & Mukhopadhyay, 2003). Differences in these positions became apparent through my experiences with vocational students and introduced me to the possibility of alternative perspectives of mathematics that may be empowering for students (Stinson, 2004) by taking account of social and epistemological issues in addition to the mastery of mathematical processes (Ernest, 2002). The conclusion reached by Boaler (2002), that teaching practices help define the form of knowledge constructed, suggests that my initial explorations into teaching mathematics in the context of vocational education were facilitating access to a form of mathematics that differed from the traditional curriculum associated with my work in school. These differences in the curriculum and approaches to implementation in the classroom are therefore important aspects to explore in the study.

From my informal observations and reflections, it seems that teaching approaches were more effective when students perceived that the mathematics had some purpose in relation to their vocational aims. Positioning mathematics as a vocationally relevant subject appeared to have benefits and how the potential of this approach could be maximised is an area of particular interest for my research.

Within this study it will only be possible for me to observe students learning functional mathematics within a short time period in college but this experience is set within a more extensive educational pathway for students in which mathematics has been a core subject. My prior encounters with the GNVQ course suggest that students entered college with existing attitudes that influenced their approach to learning mathematics in college, affected their social behaviour in the classroom and impacted on the learning process. Social and affective dimensions will therefore be important to consider in the study and adopting a view of learning mathematics as a socially mediated activity seems appropriate. A consideration of the effects of prior experience would suggest some similarity to the perspective taken towards adult learning and the basic framework of social, emotional and cognitive dimensions suggested by Illeris (2003) for studies of adults provides a useful broad conceptual base on which to build the study.

My interest in developing effective teaching for mathematics continued through my career but management positions brought responsibilities for maximising funding and balancing budgets that sometimes conflicted with my intentions to provide the best experience for students. Reconciling government directives, measures of ‘performance’ and changing funding levels with my beliefs about the learning needs of students required increasingly complex solutions. Improving teaching and learning was no longer simply about individual teachers and their classroom practices but was subject to surrounding influences from policies, systems and procedures. My approach to the research, therefore, reflects a view that teaching mathematics to vocational students is a complex, multi-faceted problem involving both the learning situation in classrooms and influences from the surrounding environment. These might be considered as elements of a foreground and background to the study that each contributes to an overall representation of the student experience.

Although gaining insight into students' perceptions of functional mathematics in the classroom will be important, there are also factors to consider associated with the positioning of their learning alongside vocational training and the situating of their experience within an educational organisation with its own culture, policies and structures. Examining the wider context in which their learning is situated seems important to place this into perspective and capture the multiple influences that may affect their classroom experience. A focus on the student perspective will position classroom practices in the foreground of the study but considering the surrounding environment will provide a background from which other key influences might be identified such as the policies and structures of the organisation. Current student experiences are situated historically within the development of vocational education and Further Education colleges. In order to better understand the current influences from within the institution then the historical situation will provide valuable background and may facilitate deeper insight.

The problem of how to teach mathematics to vocational students and support the learning effectively through appropriate policies, structures and systems was one that I was keen to investigate because it presented a challenge that, in the highly-pressured environment of Further Education, seemed to have no easy solution. It did, however, affect the learning experiences of many students. My personal experience of having insufficient time to explore the problem as a manager in Further Education seems to mirror the current political situation in which attainment in mathematics is a priority but research into the learning experience of students in Further Education with mathematics is limited (Hernandez-Martinez et al., 2011). With increasing numbers of post-16 students now being required to take a mathematics course, whether by studying for GCSE, a functional mathematics or an alternative qualification; a detailed examination of the factors affecting the student learning experience seems overdue.

The limited attention from researchers means this area presents a wide range of possible aspects for the study and selecting a single element seems inappropriate before exploring the experience of these students in a more holistic manner. In examining these factors a number of theoretical perspectives will be encountered through the literature with particular relevance to different aspects of the student experience. These may be useful to gain insight into the different sections within the study but are unlikely to provide any single theoretical framework appropriate for the holistic approach.

1.4 The content and structure of the thesis

My initial reflections and discussion have led towards a fairly holistic approach to the study. The intention is to examine the student experience of functional mathematics, identify the influential factors and explore their effects on student learning. In this subsection the main aspects of interest for the research will be briefly introduced before exploring these areas in more detail through the literature in the following chapter. The subsection will then conclude with a short overview of the structure of the thesis.

The aim of identifying different factors and exploring their effects suggests a main research question that can be stated as:

- What factors influence the experience of vocational students with functional mathematics?

Within the study, however, the intention is not only to identify the main factors but examine how they affect the student learning experience.

My reflections on personal experiences in the previous section suggest that influences on learning may arise from current classroom practice or prior experience but organisational features such as policies, structures, systems or vocational culture may also have an effect. In particular, the responsiveness of students to vocationally-related material indicates that the relevance of mathematics may be a key aspect to explore. This suggests four main areas for consideration:

- The influence of the *college* through policies, systems and organisational culture
- The influence of *prior experiences* of students, particularly on their attitude to functional mathematics
- The effects of different *teaching approaches* on student learning
- The *relevance* of functional mathematics to students on vocational programmes.

In my development of the study the literature was important in shaping the research questions and therefore the following chapter will be used to show how these key areas were explored before stating the research questions in full at the end of Chapter 2 (page 71).

The structure of the thesis is based on four sections, each containing one or more chapters, as outlined below.

In *Chapter 2* a range of literature will be examined that relates to the possible areas of influence regarding the student experience already highlighted in this introductory chapter.

The historical background forms an important foundation from which features of the learning environment in Further Education colleges, such as the structures, policies and cultural influences of the organisation are examined before considering the current functional mathematics curriculum, the teaching approaches and particular characteristics of the student cohort. The chapter concludes with a summary of the areas to be addressed and a full statement of the research questions.

Chapter 3 will address the methodology for the study to explain the decisions made and provide justification for the research design. A section on implementation will also illustrate how the research plan was actually enacted, highlighting the decisions, adaptations and further development needed to suit the complex demands of working in these Further Education colleges.

Chapters 4 and 5 provide the analysis section of the thesis, within which the main themes that emerged from the data are explained using the case studies constructed. In Chapter 4 within-case analysis of three contrasting case studies of student groups is used to introduce the themes. These are then explored in more depth through a longer cross-case analysis in Chapter 5.

Chapters 6 and 7 include the main discussion and the conclusions for the study. In Chapter 6 the main themes will be further analysed and discussed in relation to the literature. This will lead to a summary of the findings for each research question before presenting the main conclusions, implications and some personal reflections in Chapter 7.

Chapter 2: A review of the literature

With respect to her study of mathematics for vocational students, FitzSimons (2002) describes her work as lying on the borders of mathematics education, vocational education and adult education. In a similar way, this study is positioned towards the periphery of three related sub-fields of education research and will involve some consideration of literature from each area. The Further Education area provides a base for the general background and organisational features of the study, whilst research from mathematics education and Further Education each contributes to an understanding of the development of the functional mathematics curriculum. Literature on the learning experience of students in the classroom will be drawn from studies of both school-based mathematics research and adult education, since research for the specific age group of interest (16-19 years), in the context of Further Education, is limited. These contributions from adult education and schools-based research will, however, need to be moderated by some consideration of the implications for students in a different life phase or learning environment.

This study takes place "within a localised boundary of space and time" (Bassey, 2007, p.143) but the literature will position the student experience within the broader social spaces and expanses of time surrounding the students' classroom experience. The scope of the review will reflect a view of the student experience as a phenomenon nested within different social spheres and subject to multiple influences. Whilst building up this wide picture of the current situation, the literature will also provide insight into the development of the current situation over time, using historical background as a means of placing the foreground into perspective. In some sections of the literature review, therefore, a historical overview will be included to ensure that current practices are portrayed with the depth that an examination of recent practices alone could not provide.

The chapter is organised into four sections to address the relevant areas that may impact on the student experience and these are briefly outlined below.

1. The origins and organisational features of Further Education colleges

This section will provide a background from the literature that sets the study in the context of vocational and Further Education. The *historical origins and current purposes of Further Education colleges* will first be examined through a brief review of the development of Further Education colleges, from disparate roots to multi-faceted providers of academic, vocational and adult education. The impact of significant events, such as incorporation, on the management and structures of Further Education colleges will lead to a consideration of the current *organisational structures for mathematics* within colleges and aspects of *organisational culture* in Further Education colleges that may have an impact on the student experience of functional mathematics.

2. The development of mathematics for vocational students

In this section the development of *mathematics for vocational students* will be examined to establish the historical place of mathematics within the adult, vocational and academic strands of further education and trace the emergence of the functional mathematics curriculum. This review will include the main policy decisions and mathematics qualifications introduced for vocational students over the last 30 years before progressing to a more general analysis of the meanings attributed to the notion of *mathematical skills for life and work*. Some of the issues that arise when preparing vocational students for the use of *mathematics in the workplace* will be considered, including sections on the difficulties of developing *transferable skills* and associated problems concerning the *assessment of functional mathematics*.

3. The effects of prior experiences and current transitions on student learning

Having considered the institutional context and curriculum goals, both in general historical terms and how they are currently manifested, this section focuses upon the students. It draws on a range of literature to explore the characteristics of this particular student cohort, including the past and present socio-cultural influences that may have an impact on their classroom experience of learning mathematics. The student *transition from school to college* will be considered, in the context of broader life changes associated with their transition to adulthood before exploring how their *prior experiences and affective responses to mathematics* may have an impact on their learning of functional mathematics in college.

4. The implications for teaching functional mathematics in the context of vocational education

This final section brings together threads from the previous sections on institutions, curriculum and students to focus on some of the key aspects of teaching functional mathematics to young adults on vocational courses in Further Education. The section commences with a consideration of the main features of the *functional mathematics curriculum* and possible teaching approaches. Attention will then turn to possible strategies to address the characteristics of *low attainment and disaffection* in students often associated with the learning of mathematics. Finally the different *teaching traditions and cultural influences* within Further Education will be considered that may impact on the student experience.

5. The research questions

Following from the literature review the main areas of interest for exploration in the study will be clarified and the research questions stated.

2.1 The origins and organisational features of Further Education colleges

2.1.1 The historical development of Further Education colleges

Although vocational education has been a "quintessential feature of traditional further education" (Frankel & Reeves, 1996, p.130), the history of Further Education colleges involves a complex series of government responses to the provision of vocational, academic and adult education in Britain. By briefly tracing the development of these strands of education through the literature, I will explore how historical academic-vocational divisions within the education system (Young & Spours, 1998) and tripartite views that separate young people into academic, technical or non-academic pathways (Pring et al., 2009) have helped to define the current situation. The recurring theme of responsiveness to the needs of the economy (Frankel & Reeves, 1996) and of unfruitful attempts to unify the curriculum (Young & Spours, 1998) also emerge as significant influences that have contributed to the environment in which functional mathematics is taught to vocational students.

Green (1990) considers that the origins of further education arise from developments during the 18th century, in the late stages of the industrial revolution. These national changes stimulated interest in technical knowledge and skills (Macfarlane, 1993) although there appears to have been little direct connection between the school curriculum and the emerging needs of industry (Ashby, 1958). At this time, formal education was dominated by the classical, liberal approach favoured by English public schools and universities (Hyland, 1999) in which a broad curriculum was valued (Lea, Hayes, Armitage, Lomas, & Markless, 2003). Training for work was seen as being the responsibility of employers rather than the state and any adult education generally took the form of informal learning from others on a voluntary basis (Field, 1996).

At this early stage, it seems that three separate strands, of school, work-related and adult education, were already identifiable and, within these unconnected streams, the foundations were laid for a significant line of division between academic and vocational provision that is still detectable in the current 14-19 curriculum (Young, 2011). The longevity of the separation suggests that differences in origins, which may appear somewhat circumstantial, became deeply ingrained in the English education system and have never been adequately addressed. This division of academic education from work-related and vocational learning has, arguably, been evident in "every significant reform" (Pring et al., 2009, p.3) but progress in reconciling the differences might be considered as minimal (Young & Spours, 1998). Although the early division appears to be mainly between institutions, later developments suggest that this is a pervasive theme through the history of English education, associated with a growing dichotomy of beliefs that are manifest in a variety of ways.

In the early 19th century, schools continued to provide a formal education, largely retaining the liberal approach (Lucas, 2004) and some adult education was available through mutual improvement societies but the emphasis remained on 'voluntarism' and self-help (Fieldhouse, 1996) rather than entitlement. Apprenticeships, based in the workplace, were the main means of providing any work-related training (Lucas, 2004) but these were run independently by employers and unsupported by public funding (Aldrich, 1999). The lack of any coherent strategy or unified national plan for education and training across these strands was noticeable. Criticisms of more recent government policy would suggest that similar weaknesses still exist, particularly with respect to the 14-19 phase (Hodgson & Spours, 2008), which includes the main age focus for this research.

During the 19th century, a significant development for both adult and vocational provision was the establishment of the Mechanics Institutes, which provided some general instruction for adults outside the workplace (Macfarlane, 1993; Musgrave, 1964). Although intended to be accessible for the working classes, attendance at the Mechanics Institutes was largely from the middle class (Fieldhouse, 1996) since the dominant ethos and assumed levels of prior education proved to be barriers for many working class people (Green & Lucas, 1999). Deficits in school education for the working classes seemed to become a disadvantage for accessing this embryonic form of further education and the inequality highlighted an existing class separation. In the presence of "power relationships in a hierarchical society" (Hyland, 1999, p.28), a "stratification of knowledge" (Young & Spours, 1998, p.51) developed that reflected patterns in society of class and power, dividing mental and manual occupations (Young & Spours, 1998) and prioritising academic thinking over vocational training. The place of mathematics within vocational education is, therefore, bound up in a complex set of divisions within which allegiance to an academic or vocational tradition seems to determine the relative worth of the subject knowledge.

The Mechanics Institutes also contributed to this knowledge division as they made further distinctions between general, scientific and technical education (Keith Evans, 1978), thus reinforcing the existing separation of academic from vocational knowledge (Hyland & Merrill, 2003). Until this time, it seems that mathematics had remained close to its classical foundation and been largely confined to academic studies. Although Rogers (1998) suggests the origins of an applied approach to mathematics lie much earlier, it seems that this more technical approach to science had much to contribute to the emergence of mathematics as a subject with a place in more than one stream of education.

Further concerns about a the need of the nation for more technical education first arose after the Great Exhibition of 1851 (Hyland & Merrill, 2003) since increasing foreign competition made it more difficult to maintain parity within international markets (Macfarlane, 1993). In 1889 the Technical Instruction Act led to a release of public funding for technical education (Lucas, 2004) for the first time and, as a consequence, a range of technical and polytechnic colleges were formed to provide instruction related to employment and industry, in both science and arts (Musgrave, 1964). Government investment in work-related training had commenced in a small way but it seems indicative of subsequent government approaches to vocational education that these changes were only initiated in response to a particular economic concern.

The intention of providing technical education seemed to be that it would supplement but not replace either work-based practical experience (Frankel & Reeves, 1996) or the specific teaching of trades (Hyland, 1996) which were controlled by the craft guilds. This was a form of science and arts education related to industry but distanced from working practices. In effect, technical education introduced a second tier to work-related education, founding a division between practical training and technical knowledge that has been influential in the subsequent development of vocational education. This new form of knowledge also introduced some additional tension. Technical knowledge was viewed with some suspicion, since it was perceived as a narrow form of thinking (Young & Spours, 1998), institutionally separated (Hyland & Merrill, 2003) and “intellectually adrift” (Lucas, 2004, p.7) from accepted classical academic knowledge. Hyland (1996) claims this ambiguous separation of trade and technical skills within the Technical Instruction Act "merely exacerbated class divisions both between vocational and general education and *within* vocational/technical education" (Hyland, 1996, p.31). It seems that vocational education itself now had its own division of knowledge, between the technical and the practical, although both strata were still seen as inferior to the academic.

The foundations of vocational qualifications soon began to emerge through the examination system for artisans established by the Royal Society for the Arts in 1856 (Macfarlane, 1993) and the formation of the City and Guilds of London Institute in 1877 which provided accreditation for vocational students in certain crafts and trades (Frankel & Reeves, 1996). Some of the Mechanics Institutes also became regional examination bodies (Macfarlane, 1993) and these diverse sources contributed to the development of a vocational qualification system in 1921 that remained separate from the school examination system for many years, demonstrating again, the long-lasting nature of these academic-vocational divisions within the education system.

The Education Act of 1902 finally laid the foundations for a national education system, co-ordinated by local and central government, and provided a framework that remained largely unchanged until the 1988 Education Act (Hyland, 1999). External changes, however, triggered new developments that had a significant effect on the direction of vocational education. During the two main periods of war in the twentieth century, government interest in work-related training was renewed (Hyland & Merrill, 2003) and then continued into the post-war years due to periods of economic recession and a need to reconstruct the country (Field, 1996). High unemployment and a weak economy seemed to provide the main reason for government interest in vocational training and the outcomes represented, once more, only fragmented attempts to solve an economic problem rather than a coherent policy for post-compulsory education.

During the first half of the 20th century, the expansion of non-vocational courses for adults and new community groups began to strengthen adult education whilst the idea that "best practice is best learned in the workplace" (Lucas, 2004, p.12) prevailed, so vocational training remained largely focussed on apprenticeships. After 1921, the introduction of technical National Certificates (Hyland & Merrill, 2003; Macfarlane, 1993) and the availability of evening courses provided a means for young men to gain a technical education (Macfarlane, 1993). Through this route the number of students studying in technical or vocationally-related education began to rise (Pratt, 2000) although day-time study opportunities were still very limited (Macfarlane, 1993).

A new Education Act in 1944 gave local authorities responsibility for both schools and the securing of provision for further education (Fieldhouse, 1996) but implementation resulted in some variability between local authorities (Lucas, 2004). The separate streams of education remained (Fieldhouse, 1996) but the development did lead to the expansion of vocational education through increased day-release opportunities and the provision of more full-time day courses. Lucas (2004) considers that this Act was largely responsible for defining further education as it is today. It seemed that three clear components were being woven into this definition: vocational training (both in the workplace and as a preparation for employment); technical education (to support the transition to work); and adult education.

There was, however, some attempt from this point in history to begin to bridge the divide between vocational and academic education through various initiatives, although Maclure (1991) dismisses these as only “half-hearted attempts to do something about industrial training and vocational education” (Maclure, 1991, p.8) that achieved very little. Vocational training was brought into the school sector through the establishment of technical schools which would, theoretically, provide an alternative to traditional secondary education. The failure of these technical schools to gain recognition and popularity might be mainly attributed to resistance from parents and employers, but the preference in society and amongst politicians for a liberal, general approach to education probably also contributed to their eventual failure (Hyland & Merrill, 2003).

A more positive view of vocational education appeared in the Crowther Report (1959) which emphasised the importance of further education for economic growth. By promoting the benefits of an extended education for all and the value of technical education for particular classes of young people (Pring et al., 2009), the report seemed to provide support for the vocational sector whilst retaining the existing divisions and inequities present in the education system.

The Russell Report (1973) highlighted the diversity within adult education and identified weaknesses but the suggestion that this sector could make a greater contribution to the economy by becoming more directly vocational (Fieldhouse, 1996) led to a growing use of Further Education colleges for the provision of adult education and contributed to a closer relationship between the vocational and adult strands (Fieldhouse, 1996). Vocational education was, however, still primarily concerned with preparing young people for the workplace (Field, 1996) by providing the practical skills and technical education for specific trades, services and industries but rising youth employment during the 1970s and the need for economic recovery led to some significant developments (Fieldhouse, 1996) that shaped future provision.

The establishment of the Manpower Services Commission (MSC) in 1973 was accompanied by a new attempt to promote vocational education from its second-class status. Prompted by a decline in youth employment, the MSC introduced a series of initiatives, including the Youth Training Scheme (1982) and Youth Opportunities Programmes (1987), which were aimed at bridging the academic-vocational gap and facilitating the transition from school to work (Lea et al., 2003). The introduction of the Technical and Vocational Educational Initiative (TVEI) scheme into schools in 1983 promoted vocational elements within the secondary curriculum (Lucas, 2004). Although criticised for being simply a political move to address an economic problem (Lea et al., 2003) by delaying entry to the youth labour market (Hillier, 2005; Hodgson & Spours, 2008) these initiatives crossed the traditional institutional and knowledge divisions. The weakness appeared to lie in a system that delegated their management to the MSC without links to the Department of Education (Hodgson & Spours, 2008), highlighting an on-going distinction between work-related training and main-stream education that probably contributed to the withdrawal of TVEI from schools when MSC funding ceased.

This era of a 'new vocationalism' was supported by the development of new vocational qualifications by the Business and Technical Education Council (BTEC) and the introduction of pre-vocational courses (Lea et al., 2003) for schools and colleges. Vocational education became better defined through the review of vocational qualifications (1985) and the establishment of the National Council for Vocational Qualifications (NCVQ) in 1986, through which new competence-based NVQ qualifications for employment were made available (Frankel & Reeves, 1996). Accreditation was still separated from the schools examination system and relied on a different form of qualification that prioritised practical competency over theoretical knowledge.

As lifelong learning became a more significant part of government policy in the 1980s (Field, 1996) interest was also generated in a continuing education for all ages. Many technical colleges had diversified into providing academic courses alongside vocational and pre-vocational programmes (Lucas, 2004) and had become multi-purpose providers for a wide age range. Although the boundaries between academic, vocational and adult education remained, these strands were no longer exclusively provided by different institutions and these colleges were becoming a major source of education for 16-19s (Lucas, 2004), although without the status afforded to schools or universities (Hyland, 1999).

The redefining of further education in the 1988 Education Act (Fieldhouse, 1996) brought the strands of technical education, work-based training and adult provision closer together for organisational and funding purposes (Gray, Griffin, & Nasta, 2005). Under the new funding regulations that came with incorporation, however, vocational and adult education courses were differentiated and a division was still apparent. On-going changes in funding levels within Further Education have continued to highlight differences in value between courses, from a government perspective, whilst also acting as a means of regulating the education available for post-16 students (Steer et al., 2007).

Attempts made to bridge the gap between academic and vocational qualifications in the 1980s (Lea et al., 2003) led towards the introduction of GNVQ qualifications in 1991. Two distinct types of vocational qualification were now identifiable in the form of NVQs, which provided a competence-based approach to learning work-related skills, whilst the GNVQ ladder provided a means of uniting academic study with work-related applications (Lea et al., 2003). Hyland (1999) describes this as forming a triple track system in which the middle ground is occupied by broad vocational qualifications such as GNVQ that provide an alternative to the academic A levels without the narrow constraints of focussing solely on occupationally-specific skills. Although these may have succeeded in engaging some disaffected students, they remained over-shadowed by the popularity of A levels (Hodgson & Spours, 2008). The GNVQ qualification was short-lived and a similar attempt to integrate academic and vocational knowledge, introduced in 2006 in the form of new 14-19 diploma, also failed to gain status and popularity before being withdrawn. It seems that, in both cases, ingrained attitudes in society had influence over government policies that eventually returned to the well-established academic-vocational division of qualifications and curricula.

Reforms of the public sector in the 1990s reflected a new political climate of ‘marketisation’ that had a significant effect on Further Education (Lucas, 2004) as citizens became consumers and services changed to businesses (Newman, 2000). Accompanied by beliefs that ‘managerialism’ could help reproduce the success of the private sector in public services organisations, these approaches created a paradox for the new Further Education colleges that emerged from incorporation in 1992. There were tensions between the flexibility required to respond to market forces (Avis, 1996; Gleeson & Shain, 1999) and the greater central control that accompanied incorporation (Gray et al., 2005). In the new education 'market' there were also added pressures due to the need for public measures of performance to allow the market of 'choice' to function effectively (Gleeson & Shain, 1999). The unprecedented level of regulation, inspection and accountability (Lucas, 2004) had wide implications for management priorities, organisational structures and college internal policies. Even after a change in government, the values of competition, choice and performance continued and, although the discourse subtly shifted towards 'modernization' (Newman, 2000) the demands for accountability remained.

A typical Further Education college might now provide a range of academic courses for 16-18 year olds, vocational courses for all ages, work-based training and adult education. Although based in one organisation, the differences between these strands of education were still largely unaddressed. The "impoverished legacy and unplanned development" (Lucas, 2004, p.3) had resulted in a patchwork of different educational fragments, brought together without a comprehensive or coherent policy to unify the academic and the vocational (Young, 2011). Further Education colleges themselves might be considered to capture the "historic failure of English education to integrate the academic and the practical, the general and the vocational" (Maclure, 1991, p.8) within a single institution.

For the last two decades, changes to policy and funding mechanisms have continued as responsibility for Further Education has moved between government departments and changing political powers have adjusted priorities for the sector. Despite these changes, Further Education colleges still provide a mixture of academic, vocational and adult provision, whilst retaining a strong association with their vocational legacy (Frankel & Reeves, 1996). The vocational element remains remote from mainstream academic education and there is no coherent government policy to connect or unite these two strands of education (Young, 2011).

This brief historical background, up to the early post-incorporation period, provides an outline of the educational context for functional mathematics in Further Education. The later post-incorporation period brought further changes to the sector but from this point the focus will shift from this general background to two particular aspects of relevance to the study. In the following sections, the college structures into which functional mathematics teachers are placed and the organisational culture within which they work will be examined in the post-incorporation period before tracing the historical development of the functional mathematics curriculum through a similar period of time.

2.1.2 Organisational structures for mathematics within Further Education

Before incorporation, the typical Further Education college had a pyramidal structure in which the heads of academic and vocational departments occupied senior positions (Harper, 2000) but organisational structures were subject to significant changes during the post-incorporation period. This was partly due to some general restructuring but specific developments also caused changes that affected the position of mathematics staff within these structures.

After incorporation, Further Education colleges and their complex internal structures still reflected some of the historical influences in the diversity of their provision (Gray et al., 2005) but new priorities emerged as they became self-governing providers of education, with responsibilities for budgets, estates and personnel (Gleeson & Knights, 2006). The increased need for strategic planning, financial management and accountability began to shape management roles and change internal structures (Leader, 2004). A new funding mechanism for colleges seemed to be a useful political tool to increase student enrolments but also reduce costs (Steer et al., 2007), adding further pressure to the challenges of the transition from local authority control to direct accountability under central government.

As existing senior managers took hold of the new priorities, their focus moved from teaching and learning towards business management, financial planning, performance monitoring and constructing external connections with agencies (Simkins & Lumby, 2002) whilst professionals in education were shaped into business managers through the influence of the new ‘managerialism’ (Shain & Gleeson, 1999). In addition, managers from non-educational backgrounds were recruited for their management or financial expertise (Hyland & Merrill, 2003) and new organisational structures emerged that shifted power away from the heads of academic and vocational departments to senior managers with financial expertise (Harper, 2000). It seems that the new accountability designed to improve the quality of Further Education was causing a drift of attention away from the curriculum due to the increased emphasis on financial efficiency.

Leader (2004) suggests that middle management roles also became more strategic as responsibilities were devolved and funding concerns seemed to be a priority for managers at every level (Gray et al., 2005). Existing management practices seemed inadequate for these roles but a new 'managerialism' created tensions in Further Education colleges between staff who retained their professional focus on education and those who adopted a new business paradigm (Simkins & Lumby, 2002; G. Watson & Crossley, 2001a). The result was a distance, or even a polarisation, between teachers and managers who had contrasting priorities (G. Watson & Crossley, 2001b) in structures where middle managers acted as mediators, balancing strategic compliance against professional educational beliefs (G. Watson & Crossley, 2001a). Structures with a traditional vertical separation between departments were now, it appears, becoming more fragmented by additional horizontal divisions between managers and staff with different values.

At this time of internal tension in colleges (Elliott & Crossley, 1997) mathematics was present in each of the different strands within Further Education but in a variety of forms, such as adult basic skills, A-level programmes, GCSE courses and vocational modules, each with very different curricula. This diversity meant that mathematics staff could be required for a range of different courses within vocational areas, general education or adult education. Although the literature has little to offer on the specific structural arrangements for mathematics during this period, the inherent divisions between these streams suggests that a fragmentation of teachers with similar subject knowledge into different sections of the college was likely. Decisions on staffing structures could be influenced by either curriculum or financial arguments in the existing college climate and servicing arrangements between departments for specialist staff provided an alternative approach that might result in greater financial efficiency.

A significant development with an effect on mathematics staffing was the implementation of the Skills for Life Strategy (DfEE, 2001) in colleges. Adult literacy and numeracy, and later Key Skills, became a priority for colleges due to demanding targets for recruitment and achievement but a need was also identified for coordinated management structures. As a part of a 'Whole Organisation Approach' (QIA, 2008) towards all English and mathematics courses at Level 2 or below, colleges were challenged to adopt management structures that facilitated effective strategic planning for this provision. Staffing structures needed to accommodate the sudden expansion of adult provision whilst incorporating other programmes such as Key Skills. A variety of models were suggested (DfES, 2003) which, in some cases, increased the central control and coordination. Alternatively, responsibilities might be devolved with literacy, numeracy and Key Skills becoming more embedded into the vocational curriculum and coordinated by a small cross-college management group. Staffing shortages for mathematics and English became a common problem in colleges at this time, due to the increase in provision and one solution was to encourage vocational teachers to undertake the teaching of Key Skills. Although later criticised as an inappropriate and ineffective strategy (Casey et al., 2006) this gained some popularity and contributed to an increased dispersion of Key Skills staff in some colleges.

As functional skills was introduced into colleges the legacies of these structures remained and these two alternative strategies, of either centralising specialist teachers into a single team or dispersing staff into separate departments, were still present. Although the integrated approach associated with a dispersed staffing structure might better facilitate embedded teaching approaches that had benefits for students (Eldred, 2005; C. Roberts et al., 2005), the possible effects on a teacher's professional identity are worth considering. Robson (2006) suggests that vocational teachers maintain a strong connection to their occupational identity and that, in general, groups of staff with similar subject knowledge often form small communities within the college structure. These help construct and maintain both their identities and practices. It seems that dispersing functional mathematics teachers into vocational departments might shape their values towards a more vocational perspective but becoming remote from a subject-focussed team culture could weaken their identities as mathematics specialists and affect professional practices.

A further implication of the reviewing of management structures for Skills for Life by individual colleges (DfES, 2003; QIA, 2008) was a consideration of which groups of specialist teachers, if any, should be brought together into a team. Similarities in curriculum content between Adult Numeracy, GCSE mathematics and Key Skills might suggest teacher identities would benefit from locating these staff in the same team but the long-standing cultural separation of adult, academic and vocational programmes might lead towards a preference for dispersion into these distinct programme areas.

Distinctions between centralised and dispersed structures are important for the study but these are also connected with the organisational culture, which may affect the values, assumptions and interactions of functional mathematics teachers with students. Organisational culture forms part of the wider context in which functional mathematics teachers are situated but also affects the social interactions within the classroom. The possible impact of these influences in Further Education on the learning of functional mathematics will now be explored further in the following subsection.

2.1.3 The organisational culture of Further Education colleges

The literature to inform this subsection includes research specific to Further Education but this is introduced and supplemented by some key themes from business-related and schools-based studies. Although Further Education colleges as organisations may be different in some respects from both schools and businesses, their dual focus on education and business management suggests that both the schools and business literature can make a relevant contribution.

Mullins (2007) describes the culture of an organisation as the informal hidden network of communications, social interactions, relationships and norms of behaviour that overlays the formal structure. This social framework creates an organisational culture that has the strength to shape the thinking and actions of individuals (Schein, 1985) and influence the working practices of the organisation. Deal and Kennedy (2000) highlight the importance of the informal network of communication in promoting the values, rules and traditions within the organisation that then influence the individual. It is the shared values and beliefs that are considered to characterise organisations (Dawson, 1996), binding a community together (Deal & Kennedy, 2000) and reproducing patterns of thinking, feeling and action (Hofstede, Neuijen, Ohayv, & Sanders, 1990). With respect to Further Education colleges, Leader (2004) takes a similar view of organisational culture, highlighting that core values, beliefs and established behaviours are fundamental to the interactions and responses of the individual. Organisational culture, as a concept, brings together characteristics of organisations that were previously identified separately (Hofstede et al., 1990) and provides a useful perspective for exploring organisational features of colleges in the study.

There is consensus of opinion that significant cultural adjustments and value changes took place in colleges after incorporation (Elliott & Crossley, 1997; Robson, 1998; G. Watson & Crossley, 2001a) but less agreement about the exact nature of culture change (Simkins & Lumby, 2002). Within the climate of a political agenda that was reshaping public services to resemble businesses, organisational changes were accompanied by shifting values and adjustments in the way staff worked (Leader, 2004). The ‘modernisation’ focus of New Labour continued to remove power and influence from educational professionals (Newman,

2000) and the developing emphasis on learning and skills focused attention on the recipient of education rather than the provider (Finlay et al., 2007). Cultural values associated with professionalism seemed continually undermined by on-going developments (Gleeson & Knights, 2006; Steer et al., 2007) as targets and funding had significant effects on both teachers and managers (Hodgson, Edward, & Gregson, 2007); acting as policy levers (Coffield et al., 2007) to change practices. Although there was evidence of the retention of some professional values (Hodgson et al., 2007), the pressures of performativity became influential (Simmons & Thompson, 2008) causing a cultural conflict between the business focus and the interests of educational professionals.

Despite the turbulence, studies suggest that many teachers retained a strong focus on student needs (Coffield et al., 2007) and some core values, such as a commitment to student learning remained unchanged (Shain & Gleeson, 1999). Defining a single dominant culture for a Further Education college, however, may be difficult. The conflicting influences within organisations with multi-purpose functions and wide curriculum diversity seemed more likely to result in a fragmented culture. The importance of teacher identity in education might suggest some shared values associated with a role-focussed culture, in which the function of the individual is significant (Handy, 1993) but the shift of power away from teachers (Robson, 1998) indicates that a power structure (Handy, 1993) controlled by financial managers would strongly influence cultural values. The departmental structure in Further Education colleges however, with devolved responsibilities and an emphasis on course teams (Leader, 2004) seems to encourage a compartmentalised culture comprising “diverse or disparate communities of teachers, focussed around specific academic or vocational interests” (Robson, 2006, p.107).

Evidence of a well-embedded vocational culture in Further Education (Colley, James, Diment, & Tedder, 2003) suggests that vocational influences in college organisational cultures may be strong. College departments have typically reflected the values of the industry they represent, causing some cultural, as well as physical separation, from other sections of the college (Tipton, 1973). Within this vocationally orientated culture, however, occupational differences produce sub-cultures, resembling the ‘balkanisation’ described by Hargreaves (1994) in which separate, insular departments bear different complexions. In view of the diverse roots of Further Education and representation from different professional cultures (Shain & Gleeson, 1999) some evidence of fragmentation might be expected and it seems unlikely that a college could be considered as a single united ‘learning community’ in the same way as a school might be viewed (Hargreaves, 1994).

Organisational culture in a Further Education college may be considered to work together with the formal structures to create an environment in which social interactions between members are influenced by the norms of the culture but individuals also shape the on-going development of the culture (Dawson, 1996; Deal & Peterson, 1999). Teachers are, therefore, subject to influences affecting their own behaviour and performance but they themselves also have varying degrees of influence over the values and behaviours of others. The cultural divisions between departments suggest that students who take an additional course such as functional mathematics may be exposed to varying influences from vocational and functional mathematics teachers rather than a single set of cultural values.

Research has shown how students on vocational programmes tend to assume the cultural values and expected behaviours of the department (Colley et al., 2003) but these may not be compatible with the values and expectations of functional mathematics teachers. Furthermore, in a view of vocational education as a ‘community of practice’ (Lave, 1988; Lave & Wenger, 1991; Wenger, 1999) vocational teachers hold powerful positions as the knowledge-holders. This perspective places functional mathematics teachers in a different position within a functional mathematics classroom since vocational students are neither aspiring to be expert mathematicians nor teachers of mathematics. For this reason relationships with students may be different from those formed with vocational teachers and the cultural influence of vocational staff may be more dominant.

Before further examining the influences of functional mathematics teachers on learning through their choices of pedagogy in the classroom, a final aspect of the historical context will be explored. This concerns the development of the functional mathematics curriculum from the policies and curricula of the late twentieth century through to the introduction of the current functional mathematics qualifications.

2.2 The development of mathematics for vocational students

2.2.1 A historical view of mathematics for vocational students

The diversity of provision within Further Education and absence of a "single, distinctive curriculum" (Frankel & Reeves, 1996, p.14) makes it difficult to identify a single place or purpose for mathematics. In the academic strand, mathematics has historically occupied a 'gatekeeping' role (Volmink, 1994) and currently controls entry to higher level study so qualifications such as A-level and GCSE mathematics are strongly positioned. For vocational students, the legacy of an ideology that emphasised the "utility of vocational mathematics to train the industrial workforce" (Rogers, 1998, p.7) seems, however, to have been influential in the development of successive curricula and qualifications.

The emergence of an idea that a set of essential skills was required as a common core for vocational training (Green, 1998) might be traced back to the early developments of technical knowledge alongside practical skills or, more latterly, to the growth of liberal studies in Further Education which was intended to provide a broader base for vocational courses (Macfarlane, 1993). Hyland (1999) suggests that the notion of underpinning the secondary and post-compulsory curriculum with some form of core skills originated from the Crowther report (1959) in which concerns were also raised that every child and adult should achieve a certain level of competency with basic mathematics as a preparation for the general demands of their future lives. Although the idea of core skills for vocational students and competency with basic mathematics did not seem to be directly linked by policy at this time, these two developments might be considered to form the early foundations of a process that led to mathematics being placed into vocational programmes as an essential component.

The type of mathematics required was ill-defined at this point with references in the Crowther report (1959) to a form of numeracy which was the mathematical counterpart of literacy and incorporated a wide range of skills. This contrasted with more narrow views at the time that numeracy was simply the ability to deal with basic arithmetic operations (J. Evans, 2000). The Cockcroft report (1982) brought a description of numeracy as having the skills to cope with "the mathematical demands of everyday life" (Cockcroft, 1982, p.11) which provided a purpose for the skills without a prescriptive curriculum. There was an intention that acquiring these skills would improve the ability of adults to use mathematics confidently within the context of everyday life, becoming comfortable with using numbers and able to interpret information provided in mathematical terms (J. Evans, 2000). In the light of the varied interpretations of the term numeracy that have developed subsequently it might be considered as a changing concept rather than a static definition, as implied in the description “mathematical activity situated in its cultural and historical context” (Coben et al., 2003, p.7).

During the 1970s and 1980s the emphasis within vocational education on developing specific technical skills for different occupations began to move towards identifying a set of generic skills required for employment across a range of occupations (Hyland, 1999). Although first identified by the Manpower Services Commission these were later refined by the National Council for Vocational Qualifications (NCVQ) during the 1980s into a smaller set of ‘core’ skills. Reports representing the interest of employers, for example from the Confederation of British Industry (CBI), supported the inclusion of core elements in vocational training (Confederation of British Industry, 1989) but there were concerns about the approach taken to developing these skills. As only prescriptive lists of skills, based on perceived deficits in the competencies needed for employment (Hyland, 1999), the early versions of core skills were considered by some to have limited educational value (Hayward & Fernandez, 2004). Disagreement about the content of core skills (Hodgson & Spours, 2002), accompanied by doubts about their conceptual basis and the way in which the skills should be taught (Hyland, 1999), added an element of uncertainty to their position in vocational education and some inconsistency regarding the placing of mathematical skills within these definitions.

In the 1980s and 1990s there were three major developments in colleges that seemed to contribute to a greater interest in numeracy and mathematical skills: the development of Access courses for mature learners returning to education, the introduction of NVQ or GNVQ qualifications and the growth of adult basic skills (J. Evans, 2000). Mathematics became important for adult students undertaking Access courses as a ‘second chance’ educational opportunity since GCSE mathematics, or an equivalent qualification, was often required for progression to further study. For vocational students, the core skills embedded and identified in NVQ and GNVQ assessment included ‘application of number’ as a mandatory core skill unit (Hyland, 1999) and so focussed some attention on the use of mathematics within vocational qualifications. Assessment objectives for these core skills were more detailed but a lack of success with their implementation might be attributed to a weakness concerning their transferability (Hayward & Fernandez, 2004).

After the Dearing report (1996), in which post-16 education was extensively reviewed, these core skills were renamed 'key skills' and became more central in post-16 vocational education although subject to different interpretations by teachers such as being remedial skills, basic competencies or vocationally-related skills (Bolton & Hyland, 2003). With the formation of a single body, the Qualifications and Curriculum Authority (QCA), to take responsibility for both school and vocational qualifications, these skills were revised. New Key Skills standards were defined (QCA, 2000) to underpin a set of Key Skills qualifications at levels 1 to 3 for use in both schools and colleges. Application of Number remained one of the identified Key Skills and therefore might now be considered as a fundamental generic skill essential for life and work.

Meanwhile, in adult education, improving the basic numeracy skills of adults, as part of adult basic education (ABE), gathered importance during the 1990's prompted by two reports from the Adult Basic Skills Strategy Unit (ALBSU, 1987, 1989) indicating that one quarter of school leavers had basic skills difficulties (Hyland, 1999). When the Moser report (1999) also highlighted a significant skills deficit in the adult population with respect to practical uses of mathematics and English, developing these skills quickly became a matter of national importance. The government response, in the form of the Skills for Life Strategy (DfEE, 2001), was designed to address this need and equip adults with the skills "to use mathematics at a level necessary to function at work and in society generally" (Moser, 1999, p.2).

This national strategy (DfEE, 2001) led to the introduction of wide-ranging reforms in the provision of English and mathematics within adult basic education. New national tests, specialist teaching qualifications, teaching materials and a national development centre were features of this reform (Steer et al., 2007) which had an impact on all mathematics courses in post-16 education at Level 2 or below. The development of national standards and a core curriculum for Adult Numeracy (DfES, 2001) that also underpinned Key Skills brought together the previously divided strands of mathematics in adult and vocational education. Furthermore, the linking of these standards to the national curriculum in schools (see Table 1, on the following page) appeared to represent a more unified approach, although differences still remained in the qualifications and assessment, as summarised in Table 2.

Table 1: Levels of qualifications

<table>
<tr><th>Adult Numeracy and Functional Skills levels</th><th>National Curriculum levels</th><th>National Qualifications Framework</th></tr>
<tr><td>Level 3</td><td rowspan="2"></td><td>3</td></tr>
<tr><td>Level 2</td><td>2</td></tr>
<tr><td rowspan="2">Level 1</td><td>5</td><td rowspan="2">1</td></tr>
<tr><td>4</td></tr>
<tr><td>Entry 3</td><td>3</td><td rowspan="3">Entry Level</td></tr>
<tr><td>Entry 2</td><td>2</td></tr>
<tr><td>Entry 1</td><td>1</td></tr>
</table>

Source: Adult Numeracy Core Curriculum (DfES, 2001)

Table 2: Comparison of mathematics qualifications used in Further Education

Qualification	Levels	Assessment	Key features
Adult Numeracy	Entry 1-Level 2	Multiple choice tests.	Knowledge of basic mathematical processes and terms.
Key Skills Application of Number	Level 1-Level 3	Multiple choice test (identical test to Adult Numeracy) plus internally assessed portfolio of application tasks.	Knowledge of basic mathematical processes and terms but also skills in applying mathematics in familiar contexts.
Functional mathematics	Entry 1-Level 2	Internally assessed tasks. Externally-assessed examination.	Application of mathematics into a range of 'real life' contexts.

Adult Numeracy qualifications were awarded on the basis of a test outcome alone whilst Key Skills assessment also involved a portfolio element to demonstrate competency with applications. The emphasis of Adult Numeracy therefore seemed to be on gaining knowledge of basic mathematical processes whilst Key Skills was more focussed on application skills.

The strategic planning required for this agenda, alongside funding incentives and demanding recruitment targets for colleges, served to raise the profile of adult numeracy in colleges but also affected Key Skills since initial targets for adult recruitment and achievement were later extended to include the 16-19 cohort. Tensions between reaching targets and addressing student needs would suggest that the impact on practices was sometimes counterproductive in terms of quality improvement (Coffield et al., 2007). The status of Key

Skills remained low in public perceptions (Hayward & Fernandez, 2004) but the need to improve skills persisted with further reports that many adults were not functionally numerate (Leitch, 2006).

In the White Paper 14-19 Education and Skills (DfES, 2005), attention was again paid to the need to develop the set of mathematics skills that “enables a person to cope with everyday life” (DfES, 2005, p.35). New pilot qualifications in functional mathematics followed, that brought together the needs of adult and vocational education with schools, in a form that was intended to become an intrinsic part of GCSE mathematics, an essential part of a new suite of diplomas for 14-19 education and a stand-alone qualification for students in adult or vocational education. How well this strategic development could fulfil such a comprehensive role was the subject of some debate during the pilot phase with questions about how mathematical functionality should be assessed (Brown, Coben, Hodgen, Stevenson, & Venkatakrishnan, 2006; Drake, Wake, & Noyes, 2012; Threlfall, 2007) and some concerns about the pedagogical approaches suitable for a functional mathematics curriculum (Wake, 2005).

The aim of functional mathematics was to provide the skills needed by individuals for several different purposes.

> The term ‘functional’ should be considered in the broad sense of providing learners with the skills and abilities they need to take an active and responsible role in their communities, everyday life, the workplace and educational settings. Functional mathematics requires learners to use mathematics in ways that make them effective and involved as citizens, operate confidently and to convey their ideas and opinions clearly in a wide range of contexts. (QCA, 2007, p.19)

This idea of a set of essential skills that would equip adults for their personal and working lives was not new, but the qualification heralded a renewed intention to address a skills deficit that had been a cause for concern for several decades. Although functional mathematics had a short life in schools and was soon withdrawn from use it has been retained in post-16 education for both adult and vocational students. The focus of this qualification, on preparing students to use mathematics in life and work, leads to a more detailed consideration of the skills required and how mathematics is applied in workplace situations.

2.2.2 The use of mathematics in life and work

In the development of mathematics for vocational students two different views of a suitable curriculum were evident. The early core skills were based on an assumption that students required a minimum basic knowledge but later the emphasis of Key Skills was on application, although both were intended to provide the skills necessary for employment. There remains some ambiguity about the mathematical skills that people actually need for life and employment (Threlfall, 2007) and these might be considered as a minimum set of skills with utility value (Ernest, 2004) that would allow the individual to 'get by' in life or a more extensive knowledge that provides access to wider opportunities.

The difficulty of being precise about the skills needed for employment was identified by Hoyles et al (2002) and is a theme through much of the literature. This problem can be attributed partially to the diversity of practice and the lack of any single definition of the workplace (FitzSimons, 2013) but is also a result of changing demands for mathematical skills (Hoyles et al., 2002; Zevenbergen & Zevenbergen, 2009). In many workplace settings the mathematical content has been categorised as relatively simple and within the scope of the current GCSE mathematics qualification but the situations are complex (Hodgen & Marks, 2013). Learning about the specific context, with its working practices and technologies is an important part of understanding how mathematics is used in the workplace (FitzSimons, 2013).

Applying mathematics in a workplace situation is very different from the classroom (FitzSimons, 2013; Hoyles, Noss, Kent, & Bakker, 2010) and the connection to school mathematics is often not recognised by adults in the workplace (Wedege & Evans, 2006). Separating the content from the context is difficult and when mathematics is embedded into tasks or technologically-dependent processes it may not be easily identified (Hoyles et al., 2002). Having a secure understanding of the relevant mathematical concepts is important (FitzSimons, 2013; Hodgen & Marks, 2013) but this is insufficient without the more sophisticated skills needed to understand the context and apply mathematics by working analytically with real data that has a particular meaning in the situation (Hoyles et al., 2002).

Hoyles et al (2010) refer to this package of skills as 'mathematical literacy' which distinguishes the concept from simply a familiarity with basic mathematical processes and applications. The implication is that interpretation and communication are important features of workplace mathematics but these are bound together with the use of technology and mathematical processes in workplace practices. This bears some resemblance to the way that the term 'quantitative literacy' has been used to encapsulate the knowledge, habits of mind and capabilities that are required for using mathematics in life and work (Steen, 2001). Although the exact skills required for quantitative literacy and the means of acquiring them have been the subject of some debate, there is some agreement that this extends beyond numerical competency to other aspects of mathematics (De Lange, 2003) and bears similarity to the intention that functional mathematics should equip learners to "use mathematical knowledge and skills in a way that empowers them to solve problems and be able to make critical and informed choices" (Wake, 2005, p.1). Forman and Steen (1999) also refer to 'functional mathematics' in a broad sense, making a distinction between applications of mathematics in the classroom that illustrate concepts so students can acquire a predetermined section of knowledge, compared to examples that prepare students for the type of problems that arise in the workplace. Developing these skills in the classroom seems to require a different approach from the traditional use of contextualised examples and some of the issues will be explored further in the following sections.

The approaches suggested by Forman and Steen (1999) are similar to the description provided within the PISA framework, which indicates mathematical literacy is the "individual's capacity to formulate, employ and interpret mathematics in a variety of contexts" (OECD, 2010, p.23). This implies moving beyond the kinds of situations and problems typically encountered in school classrooms towards the use of mathematical reasoning in conjunction with an understanding of how mathematics is applied in the world. The intention is that individuals should be able to make the "well-founded judgements needed by constructive, engaged and reflective citizens" (OECD, 2010, p.122). Using mathematics in the workplace seems to require a sound grasp of concepts in combination with the ability to reason and apply mathematics to 'realistic' problems. It appears that the approaches associated with mathematical and quantitative literacy may offer a closer alignment to the needs of the workplace than traditional classroom teaching but developing these in a classroom situation may still present some difficulties.

Mathematics is not a value-free subject and the meanings of both constructs and symbolic representations are "intricately bound together with socio-cultural meanings, values and beliefs of students in transition experiences" (Presmeg, 2002). Although the cognitive processes may appear to be similar, the social context in which the learning takes place affects the object of the activity and the meaning attributed (Williams, Wake, & Boreham, 2001). In a work situation the fusion of mathematical skills with the work context (Hoyles et al., 2002) changes the way the actual mathematics is viewed because meaning for the mathematics is derived from the work situation (FitzSimons, 2013). Furthermore, in a mathematics class students' interpretations of mathematical problems are likely to relate to classroom goals rather than ones associated with the workplace (Aydin & Monaghan, 2011) and so their perceptions of the purpose are also different. In a work situation, mathematics forms part of larger activity and is just "one tool in the process of achieving a desired outcome" (FitzSimons, 2013, p.8). The prime aim is to achieve the task outcome rather than to learn about mathematics itself (Threlfall, 2007) and the purpose for the mathematical processes is to contribute, in some way, to the completion of a wider work-related goal.

The methods of performing mathematical processes in formal and informal situations may also be very different (Carraher, Carraher, & Schliemann, 1985) even if the mathematics involved is the same. Using mathematics in the workplace often involves informal methods that are adapted to the working environment (Pozzi, Noss, & Hoyles, 1998). FitzSimons (1999) explains how terminology that is specific to the workplace may also add to the disguise so that employees fail to identify certain activities as mathematics despite a dependency on mathematical knowledge or processes (Wedege & Evans, 2006).

Workplace activities may then be based on the use of artefacts and processes that could be considered as already 'mathematized' (Pozzi et al., 1998) so that the mathematics is embedded into one larger, work-related process, often interwoven with technology (FitzSimons, 2013; Hoyles et al., 2002). This integration of mathematics into working practices may mean it is so deeply embedded into the instruments and routines of the workplace that it is locked into those processes and hidden to the user or observer (Pozzi et al., 1998; Wedege, 1999). In the literature, cultural-historical activity theory is often used to explain these phenomena, viewing certain established tools and habits as boundary objects that connect the original mathematics across time to the daily working practices (FitzSimons, 2013; Kent, Noss, Guile, Hoyles, & Bakker, 2007; Williams et al., 2001). The connections, however, may not be apparent to the workers, or to those observing from outside and only in situations when a breakdown of routine processes occurs will formal mathematics become visible again (FitzSimons, 2013) because it then provides a means of finding a solution.

Other differences between classroom and workplace arise from values within these contexts. In work practices the importance of accuracy and freedom from errors is paramount (Threlfall, 2007) since goals such as efficiency have implications for the success of businesses (Hoyles et al., 2002). Health and safety concerns in the workplace may demand a high level of precision for certain occupations, for example chemical-spraying (Fitzsimons, 2005) whilst accurate estimations are vital for others (Zevenbergen & Zevenbergen, 2009). In the classroom, the risks associated with inaccuracy are low and errors may be used as a means of learning (FitzSimons, 2013). It seems that although some learning may be necessary in the workplace the emphasis is on accurate performance, whilst in mathematics classrooms learning might be considered as the main activity, in preparation for accurate performance at a later date in a formal assessment.

Developing mathematical skills in a classroom for effective use in the workplace, or any other life situation, seems to be dependent on teaching approaches that enable students to transcend situational boundaries and develop transferable skills. The functional mathematics curriculum provides a stated intention that students should acquire transferable skills and be able to apply mathematics in a range of 'realistic' life situations (QCA, 2007) but difficulties with the transferability of learning are well-documented. Some of the relevant literature will now be used, in the following subsection, to expand on the nature of these difficulties and indicate how transferable skills might be developed in a classroom situation.

2.2.3 The difficulties of developing transferable skills

Transferability may be considered as the ability to apply knowledge learned in one setting to a different situation (Singley & Anderson, 1989) or as the construction of learning in one situation that enhances or undermines performance in another (Perkins & Salomon, 1992). For mathematics learned in formal education but then applied in situations outside the classroom, the transfer involves moving from a structured to a semi-structured or unstructured situation. The inconsistency of knowledge transfer is a particular problem that has wide implications and Boaler (1993) suggests this is due to a complex inter-relationship of the situation in which learning takes place and the one in which it is applied. Explanations of the actual process and how knowledge transfer may be achieved have been provided from a range of theoretical perspectives.

Considerations of knowledge transfer in early research were often dependent on cognitive theories arising from the study of psychology and considered the individual learner rather than the social situation (Perkins & Salomon, 1992). From this view, individuals would construct their own abstractions and mental schema that could be transferred and applied to a different situation (Singley & Anderson, 1989). It was assumed that once a mental representation was in place then this would mediate the transfer of knowledge between contexts without further problem. A behaviourist approach suggested that using repeated practice to reinforce the behaviour desired would facilitate replication in a different environment (Greeno, 1998). There was an assumption that, with clear communication by teachers and adequate practice, students could develop secure knowledge and then use this in other situations. Knowledge was similar to a possession that was acquired by an individual and readily moved from one situation to another (Boaler, 2002).

The assumptions underlying these theoretical positions were later challenged by research that compared competencies learned within an informal situation to performance of similar tasks in a more formal setting (Lave, 1988; Nunes, Schliemann, & Carraher, 1993). These studies showed that students who could cope with problem-solving in the supermarket were less confident with similar tasks in a classroom (Lave, 1988) and young street-sellers who were competent with certain mathematics in their work situation could not demonstrate the same ability in a more formal situation (Nunes et al., 1993). Interest in this contrast between mathematics learned in formal and informal situations (Nunes et al., 1993) led to more community-centred studies with considerations of 'folk' mathematics and 'ethno-mathematics' (D'Ambrosio, 2001). These highlighted how culturally-influenced interpretations of mathematical concepts within different communities produced particular difficulties for knowledge transfer.

A socially and historically situated view of learning (Walkerdine, 1988) provided an alternative perspective. Viewing learning as a collective, social process rather than an activity centred on the individual (Lave, 1996) was fundamental to a new approach to the problem in which students were seen as participants in 'communities of practice' (Lave & Wenger, 1991). Knowledge was constructed in this community but was constrained by the boundaries of the particular social situation. Although this theoretical perspective provided an explanation of the phenomenon, it seemed to leave little opportunity for an understanding of how knowledge in different social contexts might be linked. The assumption that each learning situation was unique and context-bound meant that transferability could only occur when these boundaries were crossed.

One approach to boundary-crossing suggested that there were differences between 'high road' and 'low road' transfer (Salomon & Perkins, 1989) that demanded different levels of abstraction, reflection and meta-cognition. Students, therefore, might find some learning easier to transfer from familiar to remote situations because of these different demands on them as individuals. Again, the explanation fitted with the phenomena observed but there were still inadequacies in both situated and cognitive approaches (Anderson, Greeno, Reder, & Simon, 2000) in explaining how knowledge transfer could occur or how transferable skills could be developed within individuals.

In research studies of workplace mathematics, socio-cultural activity theory has been widely used (FitzSimons, 2013) and provides a useful theoretical framework. From this perspective, the classroom and the workplace are seen as separate activity systems but tools or artefacts that appear in both systems may be considered as boundary objects that provide links between the two situations (FitzSimons, 2013; Kent et al., 2007; Williams et al., 2001). These links between the systems provide some connections for students between formal mathematics and the workplace that can explain the interrelation of mathematical constructs in both situations.

Roth (2013), however, in his study of electrical conduit-bending in college and workplace, rejects the concept of boundary-crossing in favour of a view which focuses on the student as a person who integrates the demands of multiple activities in different situations. This integration involves active participation in both school and work activities with an accompanying personal narrative that accounts for the differences (Roth, 2013). In this way the conflicts between the two situations are reconcilable rather than remaining in opposition.

In these socio-cultural perspectives there are tools, objects or the individuals themselves that connect the two situations and the implications are that strengthening these links may help students understand the applications of mathematics in different situations. Various studies involving comparisons of workplace and classroom practices can be found in the literature but few incorporate the student training phase in vocational education as part of the process, which is the prime interest for this study. The studies suggest, however, that teaching functional mathematics requires the building of connections to help students cross boundaries between contexts and that different approaches are required compared to the traditional methods of a content-based curriculum. Before exploring possible teaching approaches more widely in a later section, one further aspect of curriculum implementation will be considered and this concerns the assessment of functional mathematics. Although the actual assessments may not be a particular focus for the study, these do have implications for the pedagogical approaches selected by teachers.

2.2.4 The assessment of functional mathematics

Statements regarding the intended purpose, aim and scope of a curriculum provide an outline for implementation by teachers but these are subject to interpretation and the curriculum received by students may be different (Mason & Johnston-Wilder, 2006). Qualification specifications and assessment methods in particular can affect teachers' perceptions of what is required and shape what is taught (Drake et al., 2012).

> One way of defining a curriculum in mathematics or a sub-set of that curriculum is to look at what is assessed and how it is assessed. That which is assessed defines the actual mathematical content of the curriculum and the way in which it is assessed defines the processes valued in the curriculum.
>
> (Roper, Threlfall, & Monaghan, 2006, p.92)

For functional skills the external assessment is expected to involve the use of mathematical tasks in realistic contexts and the application of knowledge, whilst also assessing problem-solving and process skills in tasks relevant to the context (Ofqual, 2012). These items present challenges, in terms of assessment methods, which are not easily resolved in formal examination settings.

Assessing functional mathematics within an examination setting, presents difficulties since the assessment questions can only produce a simulation of a situation, dependent on word descriptions of the scenario and limited information compared to actually experiencing the situation in life. The task therefore lacks the purpose and meaning it would have in a real life situation (Threlfall, 2007) and students will not think or behave in an examination as they would in an everyday situation (Drake et al., 2012). Functionality implies using mathematics for a purpose (Brown et al., 2006) but the assessment task assumes a purpose related to passing an examination rather than one related to the context of the problem.

Using a context for a mathematical problem involves interpretation and therefore engagement in additional cognitive processes in students' minds that may threaten the construct validity (Ahmed and Pollitt, 2007) since the question may no longer strictly be measuring the intended understanding or skills. It is important that assessment tasks should avoid presenting "unreasonable obstacles to success in the mathematical aspects of the assessment" (Threlfall, 2007, p.45) but using contextualised questions adds elements of comprehension and interpretation that may present additional difficulties. Descriptive features may be superfluous to the mathematical processes but necessary to make the situation meaningful. Alternatively, problems with a minimal description of the context may be seen by students as simply a mathematical exercise (Threlfall, 2007) and they may fail to engage with the context. In this case the question may not actually assess whether students are functional and have the ability to use mathematics outside the classroom (Threlfall, 2007) so the assessment lacks validity.

Early considerations of assessment methods for functional mathematics proposed that "authentic mathematical activity in functional ways" (Brown et al., 2006, p.32) would be needed. The authenticity of the simulated scenarios used in a formal assessment setting may improve the validity of test items for functionality but this also raises questions about whose perspective to take on what is meaningful and authentic (Drake et al., 2012). Ahmed and Pollitt (2007) suggest that the concept of 'focus' may be more appropriate for establishing the validity of contextualised test items. Using an approach in which the main features of the context mirror the main issues within the mathematical problem the design is intended to "help activate relevant concepts, rather than interfering with comprehension and reading" (Ahmed & Pollitt, 2007, p.201). This may represent an authentic use of context for assessment purposes but whether this enables an assessment of functionality is still debatable. In a study of items from different formal mathematics assessments, representations of mathematics as 'human activity' were often no more than superficial wrappings around routine calculations rather than questions that could facilitate the type of problem-solving in 'realistic 'scenarios that functionality requires (Drake et al., 2012).

It seems that the functional mathematics curriculum may have some potential for the development of skills appropriate for the workplace but assessment methods and interpretations by teachers will determine whether the curriculum received by students matches the stated intentions. Classroom practices will be further explored in the final section of this chapter but attention will firstly be turned to the students themselves, the effects of their transition into college and the prior experience they bring to the learning situation.

2.3 The effects of current transitions and prior experiences on student learning

The previous sections suggest that the transfer from formal education in school to a vocational programme in a Further Education college will bring students into contact with a different strand of education, a contrasting learning environment and a new curriculum. In this section, the transition from school to college will be explored in the context of personal life changes and past experiences, followed by a consideration of some of the factors that may have an impact on students' dispositions towards learning functional mathematics in college.

2.3.1 The transition from school to college

The transition from school to Further Education in Britain has received little attention in the literature (Hernandez-Martinez et al., 2011) but this change for students lies within the context of broader transitions affecting in this age group. In this section, therefore, some of the key features of this life phase will be examined through the literature on youth transitions and school to work transitions since these are inter-related processes in the pathway to adult life that provide the surrounding context for the transition from school to college.

> The transitions from school to work, from adolescence to adulthood, from dependence to independence are of course tightly woven in and through the lives of young people 'growing up'.
>
> (Grossberg, 1996, p.89)

For students who move into vocational education at age 16 years the changes associated with this transition are set in the context of these personal transitions from adolescence to adult life and employment. This period of personal development has been the subject of some debate as to whether it constitutes a distinct life phase, which may be described as 'emerging adulthood' (Arnett, 2000; Tanner & Arnett, 2009) or is simply part of an extended adolescence (Côté & Bynner, 2008). There is some agreement, however, that traditional features of adulthood in many western societies are being delayed (Brannen & Nilsen, 2002; Côté & Bynner, 2008). Reduced youth employment opportunities and an extended period of education delay entry to employment (Brannen & Nilsen, 2002) meaning that commonly accepted features of adulthood, such as leaving full-time education, leaving the parental home, securing full-time work throughout the year and having children (Côté & Bynner,

2008) are not economically accessible for young people and are postponed. Many young people, therefore, are experiencing a longer period of transition before taking on the adult responsibilities, creating an extended period in which individual identities are being created and recreated in response to changing circumstances (Ball, Maguire, & Macrae, 2000).

The sequencing of specific life stages might also be considered to have undergone a de-standardisation in society since there is now more diversity in the ages at which key events take place (Karen Evans, Schoon, & Weale, 2012) and the pathway towards adulthood can seem uncertain as the social markers of these life transitions become less predictable (Heinz, 2009). There are some indications, however, in the literature that traditional features of the transition to adulthood are now of lesser importance to young people than being able to make independent decisions and take personal responsibility for oneself (Arnett, 1997; Greene, Wheatley, & Aldava, 1992).

During this transition, students make choices regarding their education at age 16 that affect the journey towards employment. The educational effects of this disruption of the 14-19 phase and the early division between vocational and academic pathways have been a concern for some time (Hodgson & Spours, 2008; Pring et al., 2009). In a society considered to be dominated by increasing individualization (Beck, 1992), students may take the view that this is an opportunity for personal choices (Beck, 1992; Giddens, 1991) and that they are in control of their own trajectory (Rudd & Evans, 1998) but research suggests that the social and economic setting has a constraining influence on these choices (Ball, Macrae, & Maguire, 2000). There is some agreement that traditional structures such as social class, gender and family have become less influential over young people in recent years (Beck, 1992; Giddens, 1991; Hubbard, 2000) but social inequalities in student aspirations and achievement still exist (Bynner, 2001; Karen Evans, 2002). Social structure and human agency are now, therefore, often seen as dual constructs that work together to influence the pathways of students towards adult life and employment (Karen Evans & Furlong, 2013; Hubbard, 2000).

Youth transitions may be seen as a ‘structured individualization’ (Karen Evans, 2002; K. Roberts, 1997; Rudd & Evans, 1998) where surrounding structures, such as family and social class, influence the choices made but young people may perceive that they are making free choices.

> The structured properties of social systems provide the means by which people act and they are also the outcome of these actions.
> (Simpson & Cieslik, 2007, p.399)

Students are active in these decisions and capable of creating a path for themselves through transitions (Hubbard, 2000) but this is a 'bounded agency' (Karen Evans, 2002) still dependent on social structures which provide both opportunities and risks (Karen Evans et al., 2012). An alternative view refers to the process as a 'rationalized individualization' and places more emphasis on the intervention required by individuals to secure the resources available through these social structures (Furlong, Cartmel, Biggart, Sweeting, & West, 2003). Despite differences in these theoretical models, there is agreement that both social structures and human agency play an important part in the transitions of young people to adulthood and therefore may have some impact on the transition from school to college.

In the transition to adulthood, the journey towards employment, in particular, is important to the individual since it affects their economic and social status but also becomes a source of identity (Turner, Harkin, & Dawn, 2000). This transition is a process rather than an event, and is part of a wider career development that starts in school (Lent, Hackett, & Brown, 1999). Traditional structures such as social class and gender have, in the past, been considered to largely determine the trajectory and framework of opportunities available for young people in this transition to employment but with higher levels of youth unemployment, the journey has become more complex and uncertain (Furlong & Cartmel, 1997; Hubbard, 2000). Career choices made as a young adult can no longer guarantee a safe trajectory towards an intended employment destination and any identity related to occupation remains uncertain during this time (Turner et al., 2000).

Lent, Hackett and Brown (1999) suggest that self-efficacy beliefs, expectations of the outcomes and personal goals are important in determining the path of an individual through this extended and fragmented transition (P. Cohen & Ainley, 2000) as young people make a series of choices that guide their route. The process may be seen as a navigation or negotiation towards adulthood (Giddens, 1991) rather than a pre-determined trajectory (Karen Evans & Furlong, 2013) and identities will continue to be shaped as students pursue their individual social pathways through the transition.

Within the context of these wider transitions, students who move from school to college at age 16 undergo a social re-orientation associated with their change in educational institution that shapes their identity (Hernandez-Martinez et al., 2011). Although the concept of identity has variations in meaning, it has been used to explain how modifications in values and behaviour can result from a change in learning environment. This identity may be based on the sense of belonging to a group, a sense of achievement and the adoption of particular behaviours that relate to the accepted group norms (Boaler, Wiliam, & Zevenbergen, 2000). Students bring their established identities from school into an environment in which these gradually become re-aligned to the values of their new community (Winbourne, 2008), modified continuously by the surrounding network of relationships. In this way the shaping of individual identities may result in changes to beliefs, values and behaviours that affect their performance in their new learning community.

The effects of the transition from to school to vocational education have implications for teaching and learning but students' experiences before college are also important since established beliefs, values and attitudes accompany them into this transition. Attitudes to mathematics, for example, may be constructed in school but still be influential over students' views of functional mathematics in college. This potential legacy of affective elements, such as beliefs and attitudes to mathematics, will now be explored further in the following subsection.

2.3.2 The legacy of existing affective responses to mathematics

In adult education, considerations of the effects of prior encounters with mathematics, embedded in social and cultural learning experiences, are important since these may either assist the learning process or present difficulties (J. Evans, 2000). Previous experiences of learning mathematics result in a personal understanding of constructs which is entwined with deeply-rooted meanings and values but these may need adjustment in order to facilitate new learning (Turner et al., 2000). This is particularly pertinent for adults returning to learning but younger people, despite a shorter life history, have a legacy from their past experiences of mathematics that forms a cognitive and emotional foundation for future learning.

There is wide acceptance that both cognitive and affective factors need to be considered to understand the learning process for mathematics (Leder, 1993; Ma & Kishor, 1997; McLeod, 1992) but the literature refers to a range of different interpretations and theoretical perspectives (Goldin, 2003; Zan, Brown, Evans, & Hannula, 2006). Although affective factors have been shown to have an influence on the learning of mathematics (Hannula, 2002) the interrelationship with cognitive functions has been difficult to define (Zan et al., 2006).

Early considerations of affect in mathematics education were largely restricted to the study of anxiety and attitudes to mathematics (Zan et al., 2006), with a dependency on statistical methods to measure constructs such as the Mathematics Anxiety Rating Scale (Richardson & Suinn, 1972) and the Mathematics Attitude Scales (Fennema & Sherman, 1976). Early studies indicated a link between affect and cognition in the context of problem-solving (Silver, 1987) but there was an assumption that mathematical reasoning required affect to be controlled or even minimised (Walkerdine, 1988).

McLeod (1992) was highly influential in attempts to clarify the concepts involved and his work led to the identification of beliefs, attitudes and emotions as the primary elements of affect. These three elements have become widely recognised as the fundamental elements of affect (Ma & Kishor, 1997) although DeBellis and Goldin (2006) also added 'values' as a fourth element and other constructs of motivation, interest and mood have also been suggested (Zan et al., 2006). The meaning attributed to each of these constructs in mathematics education literature has, however, shown some variation.

Beliefs may include those held personally about mathematics education, about the social context and oneself as a learner (Hannula & Laakso, 2011; McLeod, 1992) but may be extended to include other aspects of beliefs about mathematics (Goldin, Epstein, Schorr, & Warner, 2011). Interest in self-efficacy beliefs, arising from the work of Bandura (1986) suggests that the beliefs of the individual about their capabilities have some influence in different ways over their behaviour, attainment or disposition towards further study (Pajares & Graham, 1999; Pajares & Miller, 1994; Pampaka, Kleanthous, Hutcheson, & Wake, 2011).

Student attitudes may be described broadly as an "emotional disposition towards mathematics" (Hannula, 2002, p.26) which has several facets: emotions during mathematical activities, emotions associated with the concept of mathematics, expectations of future consequences and also the value of mathematics in relation to individual goals (Hannula, 2002). Alternatively Di Martino and Zan (2011) suggest a three-dimensional model of attitude to mathematics involving emotional disposition, personal vision of the subject and perception of competence. This links emotions closely to attitude but introduces ideas of expectations and personal confidence.

The relationship between emotion and attitude may be explained further in a model that considers emotions to be the less stable aspect of attitude (Hannula & Laakso, 2011). McLeod and Adams (1989) viewed emotions as transitory experiences during problem-solving but both stable traits and rapidly changing aspects of different affective elements have been recognised (Goldin, 2003; Hannula & Laakso, 2011; McLeod, 1994). These were first positioned by McLeod (1992) on a scale that indicated the increasing stability of the elements. In this model, beliefs form the most stable element of affect, followed by values, attitudes and emotions, which are more fluid but also more intense (J Evans & Wedege, 2004). Both positive and negative emotions have now been seen as potentially productive in the learning process (Goldin et al., 2011) since negative emotions can actually stimulate activity. Repeated emotional experiences, however, can lead to more stable attitudes being established (Zan et al., 2006) and the consequences may or may not be beneficial.

Recent studies have shown an increasing emphasis on emotions rather than beliefs or attitudes, emphasising the dynamic and changing nature of the processes involved (J Evans & Zan, 2006). A range of socio-cultural approaches have highlighted the importance of the social context in shaping affective responses (J Evans & Zan, 2006). These have taken different perspectives based, for example, on a socio-constructivist or a discursive approach. The socio-constructivist view of affective responses within the learning process suggests that these are rooted within social practices and defined by the social context (Zan et al., 2006). Discursive perspectives situate affect within social practices but consider the positions made available to the individual that have an impact on cognitive and emotional responses (Zan et al., 2006). Both of these approaches would suggest that the association of emotional responses with the social situation of learning is a connection to be considered in the study.

The link between affect and actual behaviour is still an area of exploration. Research in the area of neuroscience supports the view that emotions often provide a basic mechanism for decision-making (Damasio, 1998) and the role of meta-affect has gained attention to account for differences in emotional and cognitive responses to the same stimulus (DeBellis & Goldin, 2006). Goldin et al (2011) suggest a model for connecting affect to behaviour in the form of a complex engagement structure, involving affective and cognitive components that together determine the response of a student to the learning situation. Although useful, these varying views of the interconnection of affect, cognition and behaviour seem to leave much yet to be explored.

Despite these variations in theoretical perspectives and models, many of these approaches may be seen as complementary rather than conflicting (Zan et al., 2006) since much common ground can be identified (J Evans & Zan, 2006). For the purposes of this study, it might be considered that a student entering Further Education has already constructed an attitude towards mathematics that is linked to cognition and behaviour in a complex framework that is sensitive and reactive to future encounters with the subject. These attitudes may be fairly stable and influence their initial disposition towards learning functional mathematics but the literature suggests that students' experiences in the classroom have the potential to stimulate new emotional reactions that can re-shape these established attitudes and responses. In the following section the focus will turn to the teaching of functional mathematics in college classrooms and the approaches that may be effective for these students.

2.4 The implications for teaching functional mathematics within vocational education

In this section some of the distinctive features highlighted in earlier sections will be considered in relation to the possible teaching approaches that may be appropriate for the situation. This will take the form of a focussed approach centred on these key features rather than a general overview of effective practices in teaching and learning. In view of the limited number of studies of mathematics teaching and learning that have taken place in Further Education, particularly with students in the 16-19 age range, then this section will, of necessity, draw on some selected adult and schools-based research relevant to the key elements identified. Firstly aspects of the functional mathematics curriculum will be considered, followed by some possible characteristics of the student cohort and finally some features of the vocational learning environment.

2.4.1 Teaching approaches for functional mathematics

The functional mathematics specifications require students to make sense of situations, represent them, analyse them, use appropriate mathematics, interpret results and communicate (Ofqual, 2012). These descriptors suggest a different way of thinking about mathematics and experiencing the subject in classrooms from a traditional didactic approach (Wake, 2005) since problems need to be discussed, analysed and interpreted (QCA, 2007). Research in schools suggests that teaching methods based on knowledge transfer from teacher to student are unlikely to produce the desired outcomes of being able to use and apply mathematics in a range of situations (Boaler, 1998). Developing the skills required for functional mathematics seems to demand a more connected exploration of mathematics rather than traditional 'transmission' approaches to teaching the subject (Swan, 2006).

Three possible approaches to functionality have been suggested: content focus, process focus or a context focus that involves the 'mathematizing' of real situations (Roper et al., 2006). The content focus seems to resemble a 'proficiency' approach (J. Evans, 2000) that assumes the transfer of knowledge and application of skills will be possible if concepts are soundly grasped. This strategy, as discussed earlier, has been considered inadequate for learning that needs to be applied across a range of contexts. Alternatively, adopting a process focus adds competency with processes to content knowledge but neither of these approaches would seem to adequately capture the purpose of functional mathematics as a tool to be used confidently in a range of different contexts (QCA, 2007) and therefore these methods seem unlikely to produce the appropriate outcomes.

The term 'mathematizing' has been used to describe part of the process within the Realistic Mathematics Education approach (RME) and this may promise better alignment to the demands of developing functionality. By using life situations as the starting point for learning this approach also provides space for developing the conceptual understanding that functionality requires (Wake, 2005) rather than simply teaching applications. Based on a type of mathematical modelling that considers models as "representations of problem situations" (Van Den Heuvel-Panhuizen, 2003, p.13), realistic contexts are used as the starting point for the construction of mathematical models that then "function as bridges to higher levels of understanding" (Van den Heuvel-Panhuizen & Drijvers, 2001, p.2). In this approach 'realistic' refers to the image being real in students' minds rather than authentic in detail. The process moves from the context to a model and then back to the original situation. Mathematical features are abstracted from the situation and a mathematical model is constructed, from which the problem is solved before applying the solution back into the context from which it originated. In this process Treffers and Vonk (1987) identified two different types of 'mathematization' taking place: the horizontal stage in which mathematical tools are used to organise the problem whilst still located in the context, followed by the vertical process of making connections and finding solutions within the mathematical system (Van Den Heuvel-Panhuizen, 2003). In this way the modelling process serves as a means of organising and working mathematically with real situations.

The use of mathematical modelling, in this sense, seems suited to an approach for teaching functional mathematics since it promotes a way of thinking that aligns to the intended purposes of being able to interpret and make sense of situations (QCA, 2007).

> Student modelling in functional mathematics involves students in making mathematical sense of a situation using their mathematical knowledge and in using their mathematics to explore the situation purposefully. (Roper et al., 2006, p.96)

There are, however, three particular characteristics of a functional approach to mathematics suggested by Ofqual (2012) that may present challenges for teachers and are worth some further consideration:

- the use of realistic contexts, scenarios and problems
- tasks that are relevant to the context
- the development of problem-solving skills

The use of "realistic contexts, scenarios and problems" (Ofqual, 2012, p.2) is a potential means of making links between school mathematics and the 'real' world but this seems to be particularly difficult to achieve (Aydin & Monaghan, 2011). Using 'realistic' contexts in a classroom usually involves written or verbal descriptions of scenarios without actually being within the situation described and research with children has shown how their interpretations of contextualised problems varied according to the assumptions that they made (Cooper, 2004; Cooper & Harries, 2002). Although some children did relate questions in 'everyday' contexts to their lives outside the classroom and make judgements based on non-mathematical knowledge or experience, others interpreted the problem as a mathematics question in a superficial disguise (Cooper & Harries, 2002). It seems that rather than making mathematics more related to real life from a student perspective, the effect can be the opposite and written scenarios that appear contrived may only serve to reinforce perceptions that mathematics is unrelated to real life.

Developing and using tasks that are "relevant to the context" (Ofqual, 2012, p.2) is also more complex than simply selecting a context to fit around a mathematical problem. Using contexts may only disguise the mathematical relations (Lave, 1988) and randomly inserting context into a question may not serve any helpful purpose (Boaler, 1993). Wiliam (1997) makes a distinction between contextualised mathematics questions that involve solving a real problem, a realistic one or performing a task that relates very little to the mathematics being taught. Alternatively, the use of context in a question may be described as authentic or artificial (Drake et al., 2012) depending on the match, or mismatch, between the mathematical problem and the context in which it is situated.

> Essential to using mathematics to model a real world situation or problem is the genesis of the activity in the real world itself.
>
> (Wake, 2005, p.9)

Authentic contextualised tasks arise from the situation, using a scenario in which the mathematical problem is naturally occurring, rather than using the context as simply a metaphor to illustrate an aspect of pure mathematics (Wiliam, 1997). For a functional approach to mathematics, using 'realistic' contexts and authentic tasks it seems that not only do the scenarios themselves have to be authentic descriptions of life situations but the tasks also need to arise naturally, representing problems that would need to be solved in the situation.

The development of problem-solving skills is also central to the functional skills curriculum but multiple meanings have been attributed to the term. The word 'problem' in mathematics may be used as a label for any question involving mathematics or be reserved for a particularly challenging task (Schoenfeld, 1992). There is some agreement that mathematical problem-solving is concerned with performing non-routine tasks (Burkhardt & Bell, 2007) and requires the development of independent thinking (Lester, 1994). This demands sound, conceptual knowledge and a connected understanding of mathematics so students can make decisions on how to approach the problem and which mathematics to use (Burkhardt & Bell, 2007). Polya (1985) outlines four phases of solving a problem: understanding the problem, drawing up a plan, implementing the plan and reviewing. In this structured approach there is a need for mathematical knowledge in order to devise and implement the plan but the role of the teacher in supporting students whilst encouraging the development of independence is also important (Polya, 1985). In addition to a secure knowledge-base, students need to be familiar with appropriate tools or techniques to use in solving problems and develop the ability to manage their own progress (Schoenfeld, 1992).

Routes to independence may be facilitated by methods of 'scaffolding' (Wood, Bruner, & Ross, 1976) where students make personal decisions but still within the security of a teacher-supported framework, or the more developed 'scaffolded-and-fading' approach (Mason & Johnston-Wilder, 2006) in which support can be gradually removed as students gain confidence. These strategies may help develop the resilience needed to be successful in problem-solving (Dweck, 2000) and the self-beliefs that influence their perceptions and choices of action (Schoenfeld, 1992).

The type of mathematical thinking required in problem-solving (Chapman, 1997; Swan, 2006) is not easily developed through the use of routine, closed questions and transmission approaches to learning (Boaler, 1998). The use of open questions and non-routine problems provide opportunities for exploration rather than replication of knowledge. Thinking mathematically is a dynamic process which enables the individual to handle more complex ideas and expands understanding (Mason, 1988) whilst a collaborative approach, in which students are engaged in tasks that encourage questioning and reflection, has the potential to develop mathematical thinking (Swan, 2006) in a way that functional mathematics seems to require.

These considerations of the curriculum, however, cannot be separated from the needs of students. In the following section, two particular student characteristics, arising from their experiences and responses to mathematics, will be highlighted and some possible teaching approaches considered that may be suitable to address these problems.

2.4.2 Dealing with low-attainment and disaffection

The two characteristics that emerge from the literature as being particularly pertinent to this study of post-16 vocational students are those of low-attainment and disaffection with mathematics. Due to the constraints on progression to the academic pathway, a higher proportion of students with low-attainment at GCSE level may be found in vocational education, particularly on courses at Level 2 or below, than in schools or sixth form colleges. This presents challenges for teachers in a culture where success is measured by attainment.

> It is far more demanding to teach those whose life history is of failure to understand and failure to be understood. For students whose life history and experience of education has been unrewarding, it is important to be given a chance to reposition themselves as learners.
> (Turner et al., 2000, p.58)

Teaching students with a legacy of failure or low-attainment in mathematics may require different approaches from those they have experienced in the past so that a more positive relationship to the subject can be developed. There is evidence that confidence and success are closely linked (Burton, 2004) and poor attainment in mathematics is often connected with low levels of self-efficacy (Pampaka et al., 2011). Small gains in achievement might improve confidence but using tasks that present insufficient challenge may not actually help develop students' thinking (Mason & Johnston-Wilder, 2006) and lead to incomplete understanding or flawed beliefs (Schoenfeld, 1988). Finding the balance between challenging and confidence-building learning activities may be difficult since this will depend on individual self-efficacy beliefs, requiring the construction of an "emotionally safe environment" (Goldin et al., 2011, p.262) for students to tackle challenging concepts.

Taking the view that confidence is a combination of self-efficacy and beliefs about oneself, Burton (2004) suggests that the social setting and the experiences that take place within the learning situation are important influences. Low-attaining students have been shown to benefit from an environment where there is extended time for learning but with some freedom, challenge and responsibility (A. Watson & Geest, 2005). Confidence can also increase when students feel they have the agency and opportunity for collaboration and reflection (Burton, 2004). It seems that a student-centred, collaborative approach to learning mathematics, using discussion-based resources and reflection (Swan, 2006) may, again, be a preferable alternative to a continuation of traditional methods for low-attaining students.

> The heart of teaching lies in interaction with the learner, with the aim that fruitful learning will take place.
>
> (Mason & Johnston-Wilder, 2006, p.13)

In a socially-constructed view of learning, these methods encourage the social interactions that are considered essential to facilitate learning and would seem appropriate to build both confidence and understanding.

The second possible characteristic of these students that may require some attention is a disaffection or lack of interest in mathematics since this has been identified as a widespread response to mathematics in secondary education (City & Guilds, 2012). Experiences of tedious work, isolation from mathematics, impersonal approaches and dull repetitive exercises may all contribute to disaffection (Nardi & Steward, 2003). Low-attaining students may lose hope and try to opt out when education only offers a dull and seemingly irrelevant experience (Turner et al., 2000) or continue with the subject whilst exhibiting signs of quiet disinterest (Nardi & Steward, 2003).

Negative attitudes often stem from a failure to see the relevance of mathematics (Nardi & Steward, 2003; Onion, 2004) and this may arise from perceptions that mathematics does not relate to students' personal goals (Ernest, 2004). Relevance may depend on whether students can identify an 'exchange value' for the qualification, a practical use for the mathematics or some transferable skills (Sealey & Noyes, 2010) that may be of benefit. Ernest (2004) suggests that, in general, views of the relevance of mathematics may be dependent on educational and political aims that have little meaning for students and their personal perspective may be neglected. The use of contextualised tasks to increase relevance may simply provide an appearance of links between mathematics and the world outside the classroom without establishing meaningful connections (Wiliam, 1997). As a means of motivating students and stimulating engagement then making mathematics relevant through meaningful contexts and applications seems a useful strategy but other factors also play a part and the process is not simple. Boaler (1993) suggests that mathematics can be more meaningful if the values of students, both social and cultural, are evident in lessons. Creating mathematical tasks that appear relevant and a learning situation that is meaningful seems to be dependent on teachers having an understanding of student perceptions and values so these can be reflected in classroom cultures and activities.

The previous sections have shown how there may be differences between the learning situation for students in vocational education and school-based studies. In the final part of this section, some of the influences on teaching practices from the historical traditions and established culture within Further Education colleges will be examined to explore how these may also affect the learning experience in functional mathematics classrooms.

2.4.3 Teaching traditions and cultural influences within Further Education

The vocational origins and diversity of students within Further Education may be major contributors to a different learning environment compared to schools or universities (Lucas, 2004) but there is also a legacy of contrasting traditions within teaching and learning that originate from the diverse strands of adult, vocational and academic education. The complexity of a rapid pace of change in the sector and transient populations of students of all ages has implications for teaching and learning (Huddleston & Unwin, 2002). Gray et al (2005) suggest that this requires teachers to be adaptable and flexible but there is also a need to see their teaching in context, understanding the connections between their own subject and the college provision (Huddleston & Unwin, 2002).

One of the influences over teaching approaches in vocational education has been due to a close association with the apprenticeship model of learning (Lucas, 2004) in which the teacher is the expert who demonstrates skills for students to practice until they become competent. This ‘community of practice’ approach (Lave & Wenger, 1991; Wenger, 1999) is similar to the NVQ competence-related model in which learning is about reproducing an outcome rather than teaching a process. There has been a common belief that to carry out this role the teacher simply needs to be a vocational specialist and competent practitioner (Lucas, 2004). Subject skills and experience were, in the past, considered sufficient for the purpose of teaching in vocational education (Robson, 1998) and pedagogy received little attention. Consequently, through much of the history of Further Education there has been limited interest in developing pedagogy and even a statutory requirement for teachers regarding a teaching qualification or a minimum level of qualification has been difficult to implement consistently across the sector (Lucas, 2004; Robson, 2006).

Other approaches to vocational teaching have adopted the view that vocational courses are a form of training and constitute an intrinsically different activity from formal or liberal education (Gleeson, Mardle, & McCourt, 1980). The teacher then becomes a trainer whose role is to prepare young people to enter the workplace as competent and qualified workers (Gleeson et al., 1980). This may involve a facilitator role for some sessions or a more didactic approach in others (Lucas, 2004) but the trainer remains the expert and learning is largely about successful replication of skills in an occupationally-related community. There has been an assumption that for this role only those with appropriate industrial experience can provide the appropriate training (Gleeson et al., 1980).

In adult education, learning has traditionally taken a more individualistic, holistic approach, building on students’ previous experience of life. The belief that adults learn in different ways from children (Knowles, 1978) has been widely accepted and has led to some rejection of the pedagogy associated with traditional school approaches, in favour of the term ‘androgogy’ (Gray et al., 2005) to describe the teaching practices considered appropriate. These methods assume a more humanistic perspective, influenced by the work of Dewey (1938) and centred on the theory of experiential learning (Kolb, 1984). There is a recognition of the experiences that individual students bring to the learning situation (Huddleston & Unwin, 2002) alongside personal changes in adults such as being more centred on problem-solving, having greater self-directedness and becoming interested in tasks for personal social roles (Gray et al., 2005). Using material relevant to the individual, the teacher may take the role of facilitator and friend (Lucas, 2004) rather than expert or instructor. With the Skills for Life Strategy (DfEE, 2001), efforts were made to professionalise the adult literacy and numeracy workforce and specialist teaching qualifications were introduced that combined subject content knowledge with pedagogical content knowledge. Embedded approaches for adult literacy and numeracy were pioneered and achieved some success (Eldred, 2005; C. Roberts et al., 2005) particularly in the teaching of adult literacy, adult numeracy and Key Skills. Despite differences in the curriculum the embedded strategy might still offer a useful approach for vocational students with functional mathematics.

The academic strand within Further Education seems to have retained a fairly liberal approach to education, distinct from the practical usefulness valued by vocational areas. Research with low-attaining students in GCSE resit classes within Further Education (Swan, 2006) indicated that traditional approaches to teaching were often used by teachers but also showed how collaborative methods introduced in the study brought benefits. Although some of these students were on vocational programmes the course was delivered as a separate subject and the curriculum focus was on knowledge and processes rather than applications.

GCSE mathematics is normally associated with the academic strand of Further Education as a discrete subject outside the vocational context but teaching any form of mathematics within the vocational environment presents additional difficulties. Robson's (2006) suggestion that the development of pedagogy needs to reflect the disciplinary context causes an uneasy relationship when a subject such as mathematics, with academic roots, is taught within a course with a vocational emphasis. Learning mathematics for vocational purposes focuses the purpose on a particular context and practical need but this utilitarian view (Ernest, 2004) is in conflict with the academic position that considers education should enable students towards a more advanced knowledge or appreciation of the subject. Students are surrounded by a non-academic culture in vocational education and it seems likely that the beliefs and attitudes of vocational teachers towards functional mathematics may have some effect on students in addition to the influence of those teaching the subject.

Students may be influenced by teachers through the teaching methods and materials selected but also by the transmission of attitudes and values that are usually communicated implicitly rather than explicitly (Bishop, 2001). The underlying philosophy of the individual teacher (Ernest, 1989) has remained a key feature in explaining how beliefs are formed and enacted in the classroom so their position with respect to the subject they are teaching is important to consider. For a mathematics teacher, their beliefs may be described as a set of views on the nature of mathematics, the nature of mathematics teaching and the process of learning mathematics (Ernest, 1989).

There remains, however, evidence of some disparity between classroom practice and teachers' beliefs (Cooney, 1985; Swan, 2006) suggesting that beliefs alone cannot account for teachers' behaviour in the classroom (Chapman, 2003). They may be important contributors to change or regulators of behaviour (Ernest, 1989) but the connection is variable. Evans (2000)_ENREF_46 suggests that beliefs are positioned in discursive practices and based on an identity constructed through social interactions. In this view the changing identity of the participant in different situations (Lerman, 2003) provides an explanation of the differences between statements of beliefs and classroom practices.

The enactment of beliefs is also intertwined with wider organisational features and social structures that may have a direct or indirect impact on classroom practice. As already discussed, Further Education is driven by financial policies, targets and quality measures, creating an environment of 'performativity' (Coffield et al., 2008) that may affect classroom practice. The pressures to achieve targets for quality and financial performance bring pressure to adopt particular practices, although, as seen earlier, there is some evidence in Further Education of teachers moderating organisational demands to prioritise student learning (Hodgson et al., 2007).

In conclusion, it seems that functional mathematics teachers in colleges are subject to some conflicting demands and influences arising from traditions with the separate strands of education represented in colleges that may affect both their teaching approaches and students' responses. Teachers may adopt approaches from academic or adult education that appear effective but this still leaves some uncertainty about the suitability when used with students at a different stage in their development, with a different curriculum and placed in a learning situation where multiple influences are present that affect their experience.

2.5 The research questions

This review of the literature suggests some potential influences on vocational students' experiences of functional mathematics from organisational factors such as the curriculum, policies, structures and cultural influences but also from social interactions in classrooms, both past and present. Existing research findings raise some questions about the effects of these factors on learning but leave several areas relatively unexplored with little empirical evidence directly related to the particular student cohort of interest for the study in the context of Further Education. This suggests that a more holistic view of the student experience may be appropriate to gain understanding of the multiple influences that affect their learning.

The areas of potential influence on the student experience identified through the literature for the study may be summarised as follows:

1. Organisational features of colleges are often quite distinct from schools and contribute to a learning environment that may have different influences on students. The structural arrangements in colleges affect both policy and staffing, thereby having, potentially, a significant influence on working practices that may affect functional mathematics students. For this reason, colleges with different structures for functional mathematics, such as dispersed and centralised are of particular interest so that differences can be highlighted in the research. Other organisational features, such as policies and systems that relate to functional mathematics provision, may vary in response to changing government priorities but enacted policies seem to influence both the opportunities available for students and the quality of their experience.

2. Within Further Education colleges, the dominance of the vocational culture suggests a possible conflict between vocational and academic influences when mathematics is added to the students' programme of study. The cultural influences present in college departments may be communicated to students and affect their own personal views and values with respect to functional mathematics.

3. The students themselves will bring with them into college a legacy of prior attainment and established attitudes to mathematics based on their previous experience. The extent to which this influences their disposition towards functional mathematics, their attitudes during the course and their progress with the subject may be significant. This issue has been explored previously with adults but rarely with this age group, who are currently only at the early stages of a transition to adulthood but are already being affected by changing values and priorities.

4. Students' classroom experience in functional mathematics lessons is fundamental to this study. The literature suggests that the functional mathematics curriculum has a different emphasis and purpose for learning mathematics from GCSE mathematics and may be suited to different teaching approaches. The impact of the functional mathematics curriculum on teaching practices has received little attention in the research and remains relatively unexplored.
5. The relevance of a mathematics course to this student cohort in post-16 education holds current interest in view of recent reports and a history of changing

government policies. Developing a suitable mathematics curriculum and qualifications for vocational students represents an area that has been historically problematic and therefore the relevance of the functional mathematics curriculum seems an important aspect of the student experience to explore.

Although there are other possible aspects that could be explored such as the effects of social background, gender and assessment methods, it was decided to focus on the areas that had emerged most strongly from the literature and my personal reflections. These five areas provide the main focus for the study and lead to the following research questions:

What factors influence the experience of vocational students with functional mathematics?

- **What effects do college policies, systems and organisational cultures have on the student experience?**
- **What influence does the prior experience and background of students have on their attitude to functional mathematics?**
- **What approaches to teaching functional mathematics are being used and what effect do they have on student learning?**
- **In what ways is functional mathematics relevant to students on vocational programmes?**

Chapter 3: Methodology

In this chapter my progression from these areas of interest to the implementation of a research plan will be explained in some detail and various methods capable of producing suitable data for exploration of the research questions will be discussed. The chapter is divided into five sections to address different aspects of the process.

1. Research approaches

From some initial reflections on an *epistemological position*, the suitability of different *research approaches* for the study will be considered. Three particular approaches will be discussed in detail: mixed method, grounded theory and case study. The contribution of each approach to the overall *research design* will be explained and justified in relation to the aims of the study.

2. Research design

The main features of the research design form the focus of this section. The *reliability and trustworthiness* of the research design will first be considered before explaining the reasons for the selection of questionnaires, interviews and lesson observations as the *main research methods*. The use of *preliminary field work* in shaping the research design will then be explained. Finally the *data collection methods and tools* will be described accompanied by explanations of how these would work together in the study.

3. Other considerations in the research design

The plan for identifying suitable colleges and student groups is explained in detail since the *selection of the cases* was a significant feature of the study. Other decisions, regarding *methods of recording data*, the *timescale* for the field work and *ethical considerations* are explained and justified in this section.

4. Methods of analysis

The mixed methods nature of the research and the grounded theory approach suggest a general *framework for the analysis* that is iterative and overlaps with data collection. An integrated plan for analysis is explained and how case studies suitable for *within-case and cross-case comparisons* would be developed. The planned chronology and *stages of integration* within the analysis are described, with details of analysis methods for particular sections.

5. Implementing the research plan

The *complexity of implementation* was a characteristic of this study that warrants particular attention. Adaptations to the research design and implementation plan were made regarding the selection of cases, the timescale and the stages of data collection. These changes were partly a planned responsiveness to analysis appropriate for the grounded theory approach but difficulties also arose from working within large, complex organisations. The section concludes with a short reflection on the particular problems encountered as a result of conducting *research in Further Education* colleges.

3.1 Research approaches

3.1.1 Reflections on epistemological and ontological perspectives

In order to make a claim of an addition to knowledge then it is important to first establish on what basis the claim will be made. As a researcher, my personal history and perspective on social research is intrinsic to the study (Denzin & Lincoln, 2003) and will affect the conduct of the research. The way we view and think about our surroundings influences our interactions with those within the research but also determines whether others accept the findings (Newby, 2010) so some reflections on the personal stance taken will be a valuable precursor to the study.

My own experience of formal education took place in an age when a scientific perspective, often associated with the positivist tradition, was dominant within formal education (Hitchcock & Hughes, 1989) but this was also a time of significant social change in which the audience for qualitative research was growing (Bogdan & Biklen, 1992). Later, as a teacher of mathematics and science, my experience continued to be influenced by a positivist approach in which the natural sciences were the accepted foundation for knowledge and 'scientific method' provided the most trusted means of conducting research (Hitchcock & Hughes, 1989). Positivist assumptions, such as being able to make independent and 'value-free' observations of phenomena, underpinned my views. Establishing knowledge seemed to rely on obtaining reliable data from quantitative methods such as experiments, surveys and tests (Newby, 2010).

After moving into educational management the limitations of quantitative methods became apparent to me within the context of quality improvement. Statistical reports presented data that highlighted areas of concern but making the quality improvements meant changing the behaviour of the people concerned. This involved a deeper understanding of the reasons behind the results. Although quantitative methods could supply performance measures, summaries and patterns, these did not reveal the complexity of the human behaviour that influenced the outcomes and a different approach was needed to provide the insight and understanding required. Consequently, my epistemological view shifted towards a more interpretative perspective in which understanding human behaviour became equally important to me as the 'scientific approach', using quantitative methods, that was so familiar.

The tension between these two epistemological positions was something that influenced my early decisions about the research design. Since my intention was to study the students' experience, this seemed more suited to an interpretative approach, in which understanding the perceptions of the participants is a primary concern (Payne, 2004). My epistemological beliefs however were still affected by the positivist influences from my early life and these produced a disposition towards quantitative methods. There was also a personal conflict in the ontological positions underpinning these two traditions. My background was based on realism and assumed a view that an external social reality existed, independent of the observer (Wellington, 2000). Adopting the alternative view, that "reality is a human construct" (Wellington, 2000, p.16) was an uncomfortable proposition.

My personal struggle between these two approaches and their associated beliefs bore some resemblance to the historical tension between these two positions, which have often been seen as representing opposing traditions (Hitchcock & Hughes, 1989) leading to different research methods. In the positivist tradition a reliance on objective and deductive approaches, using quantitative methods such as hypothesis-testing (Bryman, 2008) aligned well to the dominant values of my education. Interpretivism, however, which favoured qualitative methods, suited my later need for more descriptive investigation within the natural setting, with a focus on meaning and process rather than product (Bogdan & Biklen, 1992). In the changing landscape of research, in which these positions may have moved closer together (Lincoln & Guba, 2000), there appears to be a wider acceptance of research which involves both quantitative and qualitative methods (Bryman, 2008). This suggests that resolving my dual perspectives might be achieved through integration rather than separation of these approaches.

Whether epistemology actually determines the research techniques selected has been questioned (Bryman, 2008) and there remains some disagreement about which approach is better suited to social research (Hitchcock & Hughes, 1989). From my position, both qualitative and quantitative methods seemed to have value for the purposes of the study. Quantitative methods, such as surveys, could indicate trends and patterns in students' perspectives of functional mathematics whilst qualitative methods, such as interviews, would allow scope to gain an "in depth understanding and detailed description" (Yates, 2004, p.38) of student perceptions and the meaning they attribute to their experience (Yates, 2004). Rather than choosing between qualitative and quantitative methods it became clear that combining them into the research design may be appropriate.

Using both qualitative and quantitative methods in the same study would involve the combination of two 'paradigms' or sets of beliefs (Briggs & Coleman, 2007). In this context the paradigm would represent a "network of coherent ideas" (Bassey, 1999, p.42) formed from basic assumptions, key issues, models and methods (Neuman, 2006), loosely bound together into a framework to provide an orientation for the research (Bogdan & Biklen, 1992). Combining paradigms would mean incorporating the characteristics and concepts of these two approaches, with their accompanying epistemological differences. Although the two have often considered to be in opposition, other researchers would have no problem using qualitative and quantitative methods together in a study (Glaser & Strauss, 1967) and so this seemed a suitable way forward.

Furthermore, Wellington's (2000) suggestion that the conflict between qualitative and quantitative methods is a false polarisation and that research can be enriched by using both approaches presented a view that suited my position. There were pragmatic reasons why certain combinations of methods would be useful (Newby, 2010) since these could provide complementary contributions (Wellington, 2000) to gain the breadth and depth of insight into the student experience that was intended. This meant that the two epistemological views would sit alongside each other in the research design, producing a tension that may not be entirely reconcilable but it was an epistemological situation that was personally acceptable and the benefits to the study were valuable. It was also compatible with an ontological position that had moved from my personal roots and assumptions of scientific realism towards a more critical view of realism, in which the value of scientific explanation and understanding from a more humanist stance could be united.

3.1.2 Making a choice of research approaches and methods

Yates (2004) suggests that the choice of research methods may be founded on a particular philosophical position which reflects a dominant paradigm, or it may involve more pragmatic decisions based on availability, time and resources. In my considerations it seemed that both these elements were present and would have an influence over the methodology.

The methodological options compatible with interpretivism included several approaches that seemed appropriate for a study in which students' perceptions of their experience were the main focus. There was a need for "an interpretative understanding of human interaction" (Bogdan & Biklen, 1992, p.34) or *verstehen* in order to gain a deep insight into the situation. Ethnography offered this sort of 'in depth' study of occurrences in natural settings from the perspective of the participants (Payne, 2004) and would provide valuable insight into the student experience but required intensive observation. This would mean limiting the scope of the research to a small group of students so that they could be studied in sufficient depth. Although this approach was an attractive means of gaining 'rich' data (Yates, 2004), in my study there were factors at different levels in the organisation, such as the effect of college policies, that would be difficult to explore through this route.

Qualitative research often involves some elements of a phenomenological perspective (Bogdan & Biklen, 1992) since there is an intention to explore meaning for the participants. Adopting a phenomenological approach would focus on "the way human beings give meaning to their lives" (Briggs & Coleman, 2007, p.20) and was suited to my aim of understanding the meaning from the perspective of the subject of the study. The methods associated with a phenomenological approach would rely on conversation and reflection rather than pre-determined research questions (Richards & Morse, 2007). This focus on the student perspective was appropriate but, having already identified some of the relevant factors and the research questions, it would seem that a more structured method of inquiry would be more suitable.

A particular characteristic of the planned research was the holistic approach to the student experience, which presented some difficulties in determining a theoretical framework that could adequately encompass the breadth of the study. The existing research base for the subject of the study was limited and the nature of the research would, therefore, be fairly exploratory. For these reasons it was decided that the research design seemed more suited to a 'theory-seeking' rather than 'theory-testing' approach (Bassey, 1999).

There were three particular approaches that seemed appropriate for consideration and each of these will now be discussed in more detail.

1. A mixed method or multi-method approach.
2. A grounded theory approach.
3. A case study approach.

3.1.3 Mixed method and multi-method approaches

Using either mixed methods or multi-method approaches would involve the use of multiple methods, qualitative and quantitative, into a research design so that these would make a complementary contribution to the study (Onwuegbuzie & Teddlie, 2003). The challenges for my research design lay in the complexity of the situation to be explored, the range of factors of interest and how these could be integrated. Several methods would be required to gather adequate data for these purposes. Choosing multiple methods “on the basis of fitness for purpose” (Day, Sammons, Kington, Gu, & Stobart, 2006, p.107) seemed an appropriate approach to gaining the breadth and depth of information required.

The intention was not only to discover what factors influenced the student experience but to investigate questions about how they had an impact. Limiting the research design to quantitative methods might identify which factors had a measurable effect but exploring how they influenced the student experience would be more suited to qualitative methods. The research seemed to require a “detailed and holistic combination of approaches” (Day, Sammons, & Gu, 2008, p.107), both qualitative and quantitative, in order to explore the students’ experience in sufficient breadth and depth. The strength of a mixed methods approach would lie in the scope for comprehensive development of the study (Tashakkori & Teddlie, 2003) and deeper understanding of the relationship between the different influences (Briggs & Coleman, 2007).

Quantitative methods could supply data about broad features of the student experience, from an ‘outsider’ perspective, whilst qualitative methods could provide more of an ‘insider’ viewpoint (Briggs & Coleman, 2007) to explore how different phenomena affected the situation. For example, quantitative data from staff questionnaires would give an overall indication of the views of the group but also highlight anomalies, trends and common features for further exploration in interviews. In this way the quantitative data could be enriched by combining the results with qualitative explanations from interviews. Similarly, a qualitative approach to gaining the opinions of students about their classroom experience could be combined with quantitative data on student attainment to provide a broader understanding of the effects of their learning experience. In both these examples, the combination of qualitative and quantitative methods seemed to be an appropriate way of gaining the data necessary for a study involving a range of phenomena.

Using a mixed methods or multi-method research design employs the strengths of both qualitative and quantitative approaches but should minimize the weaknesses (Johnson & Turner, 2003) so the study is enriched. This can improve the quality of the findings since there is opportunity for triangulation that can strengthen the research methods. Although the design may need some careful construction to ensure the multiple methods work together in a complementary fashion, the successful combination should produce more robust findings.

A further consideration was whether the proposed research design would constitute a mixed methods or multi-method approach. Although both involved a combination of methods, a distinction could be made on the basis of the role of each component and the dominant theoretical drive (Morse, 2003). The decision, therefore, would be dependent on whether implementation required sequential or concurrent data collection, whether one method would be dominant and how integration would be achieved (Cresswell, 2008). In my study, descriptive accounts of the students' experience, from both students and teachers, could be supplemented by lesson observations and integrated with some quantitative measures of student progress from college data. This might be viewed as mixed methods with qualitative methods being dominant (Cresswell, 2008; Tashakkori & Teddlie, 2003) but it could, alternatively, be considered as a qualitative approach with some quantitative elements. One of the crucial factors would be whether the quantitative and qualitative data would make an equal contribution to the research or whether the qualitative approach would dominate. In addition, although the integration could be carried out at different stages (Cresswell, 2008; Morse, 2003), a lack of integration would suggest a multi-method rather than a mixed methods study.

The research design at this stage had the potential to become a mixed methods study but this was not yet conclusive because it was dependent on how significant the quantitative contribution would be and the level of integration that could be achieved. In a 'theory seeking' approach flexibility is needed to respond to interim analysis and therefore planning a mixed methods approach would be a useful starting point although this may develop towards a multi-method study during the research period.

3.1.4 A grounded theory approach

For a study that seemed likely to be fairly exploratory, grounded theory offered a suitable approach in which “theory is both determined by and a determinant of data collection” (Wellington, 2000, p.88). Its origins in the work of Glaser and Strauss (1967) as a response to criticisms that qualitative methods were not sufficiently robust suggested this approach would further strengthen the findings from my study. Although two distinct forms later emerged, with Glaser retaining a prescriptive method, often described as classic grounded theory, it seemed that the more relaxed approach taken by Strauss and Corbin (1998) was more accessible. Criticisms of the lack of rigour of the more flexible methods (Newby, 2010) however would suggest that the implementation should not become too detached from the original principles.

These principles, that theory is “derived from data, systematically gathered and analysed through the research process” (Strauss & Corbin, 1998, p.12) in an inductive method that originates from the data and searches for pattern (Newby, 2010), offer more to the study than a simple pattern analysis (Richards & Morse, 2007). The approach would require a set of concepts and ideas as a starting point but data collection and analysis would be integrated into an iterative process involving constant comparison. Initial ideas would be tested against data collected and decisions compared against new data until concepts became sharpened and theory consistent with all the data could be stated (Huberman & Miles, 2002). This process of abstraction from the data, leading to the emergence and construction of theory (Richards & Morse, 2007) seemed to suit my intentions for a ‘theory-seeking’ study since a theoretical framework would not be required in advance but the research would be founded on a clear set of concepts. Whilst providing useful procedures the approach offered scope for continuous “interplay between researchers and data” (Strauss & Corbin, 1998, p.13) and an interaction of analysis with data collection over time which would be compatible with a study planned to take place over a period of several months. There were aspects of a classical grounded theory approach, however, that would require some careful consideration.

Firstly, in a grounded theory approach the expectation that data collection and analysis would continue until a ‘saturation point’ was reached presented some concerns since this process can be time-consuming, intensive and unpredictable. Trying to reach a ‘saturation point’ with my study did not seem a realistic practical proposition since constraints on the availability and willingness of participants in colleges could limit opportunities for data collection. There was also the possibility that following this approach might require the data collection period to be extended or changed at some point in response to the on-going analysis. This might cause some difficulty since gaining access to colleges would involve a prior discussion of the boundaries of the research with college managers and later additions may not be welcome.

Secondly, although classic grounded theory offered a rigorous approach to theory-building the process was very prescriptive, whilst the later, more flexible, versions of grounded theory were seen as less thorough. Choosing between these alternative positions had implications for the quality of the research but practical constraints on data collection times from colleges might mean using a method that lay somewhere between these two positions.

The suggestion that grounded theory is really "a lens provided by a method that enables abstraction from the data" (Richards & Morse, 2007, p.59) provided a useful perspective and led to a decision to incorporate the general approach of grounded theory into my research design without every detail of the prescriptive classic method. For Strauss and Corbin (1998) grounded theory was actually a style rather than a method and therefore the original structure became less important than the principles on which it was based. My research would adopt the style and principles of grounded theory but also retain the features of a mixed methods approach within the research design.

3.1.5 A case study approach

Since my intention was to study a small number of colleges in detail, a case study approach which involves the study of "a singularity conducted in depth in natural settings" (Bassey, 1999, p.47) seemed appropriate to consider. Bogdan and Biklan (1992) suggest that case studies may take several forms such as a historical-organisational focus, an observational study of a current situation or a life history. My study would be observational, focussing on contemporary events (Yin, 2009) and a case study approach suited these key features but without requiring the control over events that experiment requires (Wellington, 2000). This seemed appropriate for the situation in which my research would be conducted where my role with student groups would be observation rather than intervention.

Using a case study as a "detailed examination of one setting" (Bogdan & Biklen, 1992, p.62) matched my intention to examine the students' experience in depth since it could involve intensive analysis of an individual unit (Bryman, 2008) within a real-life context (Yin, 2009). By taking a probing approach (Bassey, 1999) in which phenomena are examined intensively (L. Cohen, Manion, & Morrison, 2007) it would be possible to become intimately familiar with each case and find unique patterns to test or generate theory (Yin, 2009). This close focus on the nature of a case and its complexity (Stake, 1995) would be appropriate for the examination of one or two colleges as case studies but could also be used to study a department or class in detail.

The case study approach is often used in the exploratory phase of research or for a descriptive use but can also be explanatory (Newby, 2010; Yin, 2009) and is sometimes considered suitable for an un-researched area or for gaining a fresh perspective (Eisenhardt, 1989). Bassey (1999) suggests that 'theory-seeking' case studies are by nature exploratory and with an area that was relatively un-researched this emphasis seemed appropriate, although the intention would be to move beyond a simple exploration to explain and enlighten rather than just describe or illustrate. The three types of study described by Stake (1995) are useful to consider: intrinsic (to gain better understanding of a particular case), instrumental (to gain insight into an issue) and collective (a number of cases that are similar or dissimilar from which theory is generated). The most relevant for the purposes of this study, to use in conjunction with a grounded theory approach, would be to gain understanding from a detailed study of more than one case. The case study approach would then provide a way of studying the students' experience in some depth whilst including the opportunity to examine several contrasting cases.

The criticisms of case study research, such as a lack of rigour from unsystematic procedures that can lead to bias in the findings and their limited capacity for generalisations (Yin, 2009) require some consideration. Issues regarding the 'trustworthiness' (Bassey, 2001) of qualitative methods will be discussed further in the following section, with respect to the overall research design, but the generalisability of case studies is a specific problem that will be considered at this point.

Limitations on generalisations depend on the nature of the case study itself and the unit of analysis (Wellington, 2000) so careful choices would be needed in the design. Rather than the types of generalisation associated with scientific or statistical studies the research could produce some "fuzzy generalisations" (Bassey, 1999, p.46) or predictions. Although the suggestion that "each case study is unique, but not so unique that we cannot learn from it and apply its lessons more generally" (Wolcott, 1995, p.175) encourages some abstraction, this does not mean generalisations can be made lightly from case studies. Theory could be developed, however, by constructing clear connections in the analysis stage using a detailed comparative method, such as that associated with a grounded theory approach (Eisenhardt, 1989; Glaser & Strauss, 1967). Developing clear constructs in advance of the study, to shape the design, would also be important (Eisenhardt, 1989) and using multiple cases for triangulation would strengthen the evidence.

The relative value of studying a single case compared to a collection of cases is an important issue and reasons for choosing a particular unit of analysis need to be matched to the research question (Wellington, 2000). For this study it was originally intended to compare the student experience in two colleges with different organisational structures, using each college as a case study. Multiple-case studies however have wider generalisability and the benefits of being able to generate theory (Yin, 2009). It seemed that multiple cases could add strength to the findings and studying several student groups at each college may enable a clearer focus on students rather than structures. An embedded design of nested cases within each college was therefore proposed that seemed to offer a more robust approach than simply comparing two college cases.

From the perspective that case study is a research strategy (Yin, 2009) rather than a separate method then using this approach in conjunction with grounded theory as part of a 'theory-seeking' design (Bassey, 1999) seemed appropriate. Since case studies can involve a range of different methods (Wellington, 2000) both qualitative and quantitative (Yin, 2009), this approach would also be compatible with the use of mixed methods and may facilitate the exploration of more complex research questions (Yin, 2009). The blending of a multiple case study approach with the systematic methods that characterise a grounded theory style offered, potentially, a stronger evidence base from which theory could be generated.

3.2 Research design

The design of the research was highly influenced by the three approaches outlined in the previous section. This resulted in a research design that was based on a grounded theory approach and used mixed methods but would lead to the construction of case studies. The selection of the case studies will be discussed in more detail in Section 3.3.1 but the original intention was to select two colleges with contrasting characteristics as the main cases. Within these colleges several vocational areas or departments would be chosen for more focussed study and within these areas a number of student groups would be examined in detail. In this way the approach might be considered as a set of nested case studies of student groups within two contrasting case study colleges.

Within this broad research plan one of the most important aspects at this point was to consider the reliability of the design in order to ensure that the findings and emerging theory would be suitably robust. In this section issues regarding reliability will be briefly discussed before describing the main research methods and justifying their purposes in relation to the research aims.

3.2.1 Reliability and trustworthiness

For quantitative methods the issues for a robust design are often described in terms of the validity and reliability of the methods to ensure the data accurately represents or measures the phenomenon intended and that similar results would be obtained if the data collection methods were repeated (Bush, 2007). The design and analysis of research instruments such as questionnaires for the study would be crucial to the validity and reliability of the results since bias may be introduced through the form of the questions, the sampling methods or size of sample (Newby, 2010). The research instruments will be discussed in detail in the following section but using qualitative methods raises some more general concerns that affect the generic aspects of the design.

For qualitative methods, the terms of ‘reliability’ and ‘validity’ are difficult to apply since these assume that replication is possible (L. Cohen et al., 2007) but qualitative methods are often based on studies of single events that cannot be replicated (Bassey, 1999). It is important that the research design can produce authentic and credible results but this may be described in terms of increasing the trustworthiness and credibility rather than ‘validity’ and ‘reliability’ (Bryman, 2008; Newby, 2010). The important consideration in trustworthiness is whether the researcher has gained full access to the knowledge and meaning of the participants (Briggs & Coleman, 2007) and the research design needs to incorporate measures to ensure that this can be achieved.

Building features into the research design such as triangulation of data from different sources (Briggs & Coleman, 2007), sustained engagement with the sources and systematic testing of an emerging hypothesis or evaluation (Bassey, 1999) have been suggested as ways of improving the quality of the findings and could be used in this study. The grounded theory approach provided a means of testing emerging theory and the time span of data collection was proposed as six to nine months which would allow for a sustained contact with the student groups. Triangulation would be the main means of guarding against subjective interpretation and strengthening the evidence from individual sources (Eisenhardt, 1989). This could be achieved by multiple uses of the same questions with different participants (respondent triangulation), using two or more approaches to the same problem (triangulation between methods) or including data from different viewpoints e.g. teacher, pupil (in method triangulation) (Briggs & Coleman, 2007). For this study all three types of triangulation were relevant and would be incorporated into the design by:

- questioning several groups of students about the same issues
- using questionnaires, interviews and observations to probe the areas of interest
- questioning both students and staff about the student learning experience.

In this way data from different respondents and viewpoints could be compared and a range of methods would be used to build up each case study.

3.2.2 Main research methods

The main research methods were selected on the basis of 'fitness for purpose' in gathering credible and trustworthy data appropriate to explore the research questions within a mixed methods strategy. These methods will each be described briefly in this subsection and some of the issues will be highlighted that require consideration when using these in a research design. A set of the main research tools can be found in Appendix 1 (page 259).

One of the most common methods of obtaining information from individual participants is the questionnaire and this seemed appropriate for gaining an overview of staff and student opinions. The design of the questionnaire required several key decisions. Questionnaires may typically involve closed response items when used as a quantitative method but more open questions for a qualitative approach. Closed questions are often criticised from a qualitative perspective on the grounds that these impose the researcher's models and theories (Yates, 2004) but are generally easier to analyse. In this study the questions would be used in conjunction with interviews, through which opinions could be explored further, so the decision was made that the majority of the questions could be closed response. Preliminary work was planned in order to shape the questions and ensure these were not entirely dependent on the researcher's pre-existing opinions.

In order to inform the research questions, the questionnaires would need to obtain information about personal attitudes. A number of scales have been developed for the purpose of measuring attitudes towards mathematics such as the Mathematics Anxiety Rating Scale (Richardson & Suinn, 1972) and the Mathematics Attitudes Scales (Fennema & Sherman, 1976) but their dependency on psychological theories and statistical methods has been criticised. These scales were considered but did not appear to address the specific areas of interest to this study. The alternative was to design a questionnaire to provide the data relevant to the research questions.

In questionnaires, constructs such as attitudes and values are often measured by attitude scales in which participants choose statements which can be scored (Payne, 2004). One means of gathering this data would be by obtaining responses to statements using a Likert scale. The advantages would be the speed of completion for respondents and the ease of summarising the results but the elements of the scale are descriptive and may be interpreted differently by individuals. Although the response categories could be assigned a numerical value these would not represent equally-spaced points on a scale and the resulting data would be only ordinal. Working with ordinal data places limitations on the statistical methods possible in analysis (Jamieson, 2004) although certain non-parametric tests might be appropriate. Some alternatives were considered but it was decided that the Likert scale would provide adequate data with sufficient reliability for this part of the study since the responses would be triangulated with interviews and observations.

The statements for use with a Likert scale needed to be clear, unambiguous, and only address one construct at a time (Bell, 2007) with careful phrasing to ensure the statements were balanced and did not lead towards any particular response (Gillham, 2000). The design process would involve developing, checking, testing and reviewing until the statements were fit for purpose. Using several statements to explore the same construct, as multiple indicators, was considered as a means of enhancing the validity of the results (Bryman, 2008) and, with sufficient data, factor analysis could be used to indicate statements with similar patterns of response that may be combined. Carrying out a pilot of the questionnaire could also enhance the quality of the findings since analysing a preliminary set of results could be used to test the spread of responses and identify any ambiguity in the wording or construction of the questions. It was decided to pilot the staff questionnaire so refinements could be made and feedback gained on the time taken for completion. Preliminary fieldwork with focus groups would also be used to develop questions for students that could then be piloted. It seemed likely, however, that the numbers of participants in these pilots and in the main study would be fairly small and therefore factor analysis was probably not going to be appropriate. This would constrain the usefulness of certain sections of the questionnaires but the alternative, of more extensive use across many colleges, was not suited to a research design focussed on a case study approach.

Maximising the number of returns from questionnaires in the main study was important to increase the validity of the results (Newby, 2010) so the type of questionnaire and the means of distribution needed to be considered. Electronic surveys tend to elicit a lower response rate and in large colleges, with many demands on staff time, these could be easily overlooked. Similarly, distributing paper-based questionnaires might lead to a low return rate since many staff would have no reason to prioritise this over other tasks. The means of returning completed questionnaires also needed to be simple but retain confidentiality. The most effective way seemed to be by introducing the research and allocating time for completion of the questionnaires during a team meeting. This approach was the preferred method but would be dependent on the co-operation and agreement of each team manager.

In a qualitative approach, interviews and observations are frequently used and both of these were appropriate for the study but the role of the researcher in these processes is a key consideration when seeking to obtain reliable data. Taking the view that the purpose of an interview from a qualitative perspective is to develop a shared understanding with the participant through interaction with the researcher (Yates, 2004), the level of interaction needed careful consideration in order to establish a rapport but avoid dominance in the discussion (Wellington, 2000). Questions needed careful construction and handling to avoid leading or restrictive questions that could affect the participant’s responses and produce bias (Wellington, 2000). There could also be a danger of distortion when interpreting the interviewee’s responses but interview recordings with accurate transcriptions would help avoid misrepresentation. Since the interviewer has to listen, understand and respond to the interviewee whilst maintaining an overview of progress and awareness of areas to be covered (Wengraf, 2001) this would place some additional demands on myself as the researcher to take a “reflective and critical approach” (Wellington, 2000, p.83) so credible data could be obtained.

Interviews, when used for qualitative purposes, typically have a loose structure with a guide to the topics rather than a formal set of questions to be answered (Bogdan & Biklen, 1992).

The approach proposed was to use semi-structured interviews as a form of ‘in depth’ interviewing (Yates, 2004) with a set of questions and possible prompts that would guide the discussion. Using these as an informal interactive conversation would allow interesting issues and new avenues to be explored as opportunities arose.

Lesson observations were also part of the research design and these would be triangulated with students’ and teachers’ perspectives on the classroom experience from interviews and focus groups. One of the main decisions about observation again concerned the role of the researcher and whether being a neutral observer or interacting participant would be more appropriate. These alternative observer roles give access to different perspectives of the situation that affect the records made by the researcher and the interpretation. Making visual or audio recordings could improve reliability but my selectivity and personal perspective would still produce some bias so the triangulation of data from different sources would be important (Moyles, 2007).

3.2.3 Preliminary field work

The purpose of the preliminary work was to gain information to inform the research design in the following ways:

- help clarify the key areas to explore
- identify any issues that may arise in the study
- inform the design of some specific research tools.

Three colleges with contrasting structures were asked to contribute. This was considered sufficient to inform the research design but broad enough for any differences in staff and student views between colleges to be represented in the data. Several staff took part in interviews: a manager with cross-college responsibility for functional skills, a functional skills team leader, a functional mathematics teacher, a personal tutor and two functional mathematics teaching teams. Focus group discussions were also held with five different student focus groups and several vocational teachers took part in piloting the questionnaires.

Interviews with staff and focus group discussions with students were used to make an assessment of the possible factors affecting the student experience, to refine the research questions and to develop the conceptual framework for the study. The responses of staff and students were also used in developing the areas to be addressed in the questionnaire and the themes to be explored in interviews or student focus groups. In particular, the focus groups were used to inform the design of a proposed activity to gather individual student opinions as an alternative to a questionnaire. Students' suggestions of statements to be used for this activity and successive refinements were then trialled with other groups.

3.2.4 Research methods for students

Since the main focus of the research was on the students' experience of functional mathematics, it was important to capture their perceptions as reliably as possible. Using a questionnaire across a wide group of students, in combination with focus group discussions, would bring the benefits from both a quantitative and qualitative approach but designing specific research tools suitable for the students was a concern.

In my personal experience, questionnaires were often treated casually by students so my confidence that these would bring reliable results was not strong. Students often perceived impersonal requests for information as unimportant and were reluctant to complete written questionnaires. Student interest in a questionnaire about functional mathematics was likely to be low so being able to engage them into an activity that they would take seriously and find easy to complete may lead to more reliable responses. Presenting the activity in person as an active method with low demands on reading and writing skills seemed to be a better strategy than distributing a questionnaire. A card-sorting activity was developed, in which questions were given verbally to the group but students then placed their sets of statements individually under headings that formed a Likert scale. Students' arrangements of the statements could then be quickly recorded on a simple grid using numbers on the reverse of the cards.

A pilot of the card-sorting activity suggested that this approach was engaging for students and my observation of the activity showed they took time to read and place the cards, which indicated that these were not just nominal responses but the result of some consideration. The statements were short and simple, so easy to read. Students' suggestions and responses in the pilot were taken into consideration to ensure that the final set of cards could be readily understood and reliably interpreted by other students. The activity was then used in the main study during the first phase of focus group meetings to obtain data from individual students prior to group discussions.

The purpose of the individual activity and the focus group meetings was to obtain opinions from students in each group on a range of issues, some of which would emerge from data collection and analysis rather than being prescribed before the study commenced. The areas for the first term discussion were determined from the preliminary work with students and were as follows:

- Students' perceptions of their general experience of school and college and any differences between the two environments
- Students' affective responses to mathematics in school and functional mathematics in college
- Students' perceptions of functional mathematics lessons.

The students in the focus groups would also be asked to provide their previous attainment in mathematics (GCSE grade or other qualification) and, at the end of the year, the level of functional mathematics they had achieved.

Obtaining individual responses from the card-sorting activity was important since focus group discussions might prove to be an unreliable data source for several reasons and triangulation with individual responses would improve the strength of the findings. There was a concern that focus groups may yield only the opinions of the most dominant members, or that conformity to college expectations may affect the results. Being asked to participate in a focus group could cause some nervousness about making verbal contributions in the group situation, or reluctance to talk freely and some students might actually have little to say about functional mathematics, particularly if they were disinterested in the subject. The combination of individual and group methods would provide two ways of gaining data that could be complementary. It also meant that the failure of one of these methods would not then jeopardise the whole study.

My approach to the focus group discussions reflected a view that these were a special type of in-depth interviewing in which the participants are encouraged to interact and discuss given topics in a group situation (Yates, 2004). Using discussion rather than a more structured group interview method would allow for exploration of the reasons for student responses and how the group made sense of different phenomena (Bryman, 2008). My intention was to act as a facilitator and moderator (Bryman, 2008), to introduce the topics for discussion and then guide and manage the situation whilst trying to maintain the interest of the group (Newby, 2010). From previous experience with college students it was anticipated that some groups may need more prompts than might typically be used in a normal focus group discussion. Whilst wishing to avoid a level of formality or structure that might constrain the discussion it was necessary to accept that intervention may be required to keep conversations flowing. This would need careful attention during the sessions and there was a possibility that some focus groups might resemble group interviews more than group discussions. To avoid this situation and improve the quality of the discussion, it seemed important to gain the trust and confidence of the students prior to the first focus group meeting so that they might be more relaxed and likely to talk freely.

3.2.5 Research methods for staff

Before the main period of data collection could commence it was necessary to gain some background knowledge about the colleges. This information would be obtained by interviewing the manager with overall responsibility for functional skills in each college. The following areas would be explored in these interviews:

- college policies and procedures for functional mathematics
- college structures and terminology
- college communication systems
- the role of personal tutors.

This would also provide an understanding of the roles, positions and vocational areas to ensure that the wording of questionnaires and interview questions would be appropriate. The perceptions of managers about the structures, policies and procedures for functional mathematics might also provide some triangulation when compared to the responses from teaching staff.

At these interviews a number of college documents would be requested to inform the study: the college policy for functional skills, the organisational structure of the college showing the departments and any information about functional mathematics provided for students prior to enrolment in a college handbook or prospectus. Certain college data reports would also be useful to indicate trends in the success rates of students within different college departments since these may indicate where teaching had been effective or highlight issues. College managers would be asked to alert the relevant information manager but the data requests would be made at a later stage since accurate reports would not normally be available until late November for the preceding college year.

For both functional mathematics and vocational teachers a combination of quantitative and qualitative approaches using questionnaires and interviews was proposed. The questionnaire for functional mathematics teachers was designed to gather data regarding:

- the backgrounds, experience and roles of functional mathematics teachers
- their perceptions of functional mathematics
- their views about students' attitudes to functional mathematics
- the teaching approaches that functional mathematics teachers were using
- their general experience of working in the college, including their relationship with vocational staff
- their personal experience of mathematics.

The questionnaire design needed to take into consideration how the relevant data could be gathered most efficiently and the time it would take respondents to complete. Although functional mathematics teachers would probably have some interest in the questionnaire, the optimum time that they would be prepared to spend was anticipated to be around 10-15 minutes. Through the preliminary work, early versions were refined to ensure completion times and interpretations of the proposed questions would be appropriate.

Most of the data would be collected through closed response items although space was also provided for alternative answers to cover unforeseen variations outside the closed responses and one open response item was included to obtain teachers' personal definitions of functional mathematics. For items regarding teachers' views and attitudes they were asked to indicate their responses to statements using a given 5-point Likert scale. For each college, questionnaires would be distributed to every member of staff who had been teaching functional mathematics in the academic year immediately prior to the study.

The purpose of the interviews was to explore areas from the questionnaire in more depth and to gain insight into some of the reasons behind the responses. Of particular interest would be any strong trends or ambiguities that required further explanation. For this reason, the interview questions would not be finalised until a set of questionnaire responses had been analysed so that the interim analysis could inform the next stage of data collection.

Interviewees who were teaching in the vocational areas of interest for the research would then be asked whether they would be willing to offer one of their student groups as a case study. Selecting cases in this way, on the basis of volunteers, would inevitably lead to some bias, since the more enthusiastic and confident teachers would be more likely to participate but, in a case study approach it was not necessary to take a representative sample, as in quantitative methods. A theoretical sampling approach, as described in more detail in the following section, would be suitable for the design and purpose of this study.

Questionnaires and interviews with vocational teachers were also part of the research design. The purpose of this questionnaire would be to ascertain the opinions of vocational tutors, in similar areas to those explored with functional mathematics teachers:

- the backgrounds, experience and roles of functional mathematics teachers
- their perceptions of functional mathematics
- their views about students' attitudes to functional mathematics
- the use of mathematics in their vocational area
- their general experience of working in the college, including their relationship with functional mathematics staff
- their personal experience of mathematics.

The questionnaire resembled the one used for functional mathematics teachers except for some minor rewording (e.g. exchange of 'functional mathematics teacher' for 'vocational teacher') and the removal of the section on teaching functional mathematics. This meant that some direct comparisons could be made between the responses. The questionnaire would also be shorter and take less time to complete, which was preferable for teachers who may have less interest in functional mathematics.

The purpose of the interviews with vocational teachers was, again, to explore the above areas in more depth and to gain insight into some of the reasons behind the responses. Selecting the vocational teachers to be interviewed would also be decided from the questionnaires on which they could indicate their willingness to participate in an interview. Decisions on which particular staff to interview would not be pre-determined but made on the basis of emerging priorities from the on-going data analysis.

3.2.6 The use of lesson observations

The lesson observations in the first term were planned to have a two-fold purpose. In order to gain the trust of the students and establish good relationships for the focus group discussions the researcher needed to become more of an 'insider' than an 'outsider'. For this reason, the first set of observations of each group were planned to be informal. It was decided to avoid any appearance of making judgements or being a formal observer by refraining from taking notes in the lesson but a written record would be made immediately after the observation. This meant that the accounts of these lessons would be limited, highly selective and influenced by the researcher's perspective but it was decided that there were greater benefits to the research from prioritising the development of positive relationships with students at this stage.

The role adopted by the researcher during these first observations was planned to be similar to a classroom assistant who was watching, listening and helping individual students whilst building relationships that might encourage students to talk in a relaxed manner during focus group discussions at a later date. The 'observer as participant' role (Wellington, 2000) within the participant-observer spectrum (Bogdan & Biklen, 1992) seemed appropriate for this purpose. Only unstructured observations would be possible in this role but these would provide some first impressions of the lessons to help identify key areas for later exploration. Other methods would provide triangulation so the compromise regarding structured observations and written records during these initial visits to lessons was not anticipated to constitute a serious threat to the final outcomes.

In the second term, the same classes would be revisited for more structured observations using a protocol designed to focus on particular aspects of interest. These areas would be determined from the on-going analysis of data collected during the first term.

3.3 Other considerations in the research design

3.3.1 Selecting the cases for the study

In a quantitative approach a sampling plan is designed to ensure items are representative of the population being considered (Bryman, 2008) but in a qualitative approach there are different principles for selection, depending on the methods being used for the study. This might give the appearance of more flexibility but a random or unsystematic approach would still be inappropriate (Eisenhardt, 1989) and therefore the selection strategy needed some careful planning. The case study and grounded theory approaches each offered some relevant guidance.

In a typical case study approach there would be a need to seek the 'unique case' or the 'critical case' or the 'revelatory case' (Yin, 2009). Cases might have replicated features or be selected to fit particular theoretical categories but could also represent 'polar types' (Eisenhardt, 1989) where contrasting elements facilitated comparisons between the cases.

Two colleges might therefore be selected as case studies for comparison on the basis of contrasting features.

In qualitative research, sampling should be purposive and strategic (Bryman, 2008) without following the procedures associated with quantitative methods (Yin, 2009). A 'theoretical sampling' method (Glaser & Strauss, 1967) could be appropriate for the study since this would involve selecting participants or cases to illuminate emerging aspects of interest. Using concurrent data collection and analysis, the grounded theory approach would allow interim analysis to inform the researcher about further data to be obtained or additional cases to be explored.

Since the nested case study approach involved selecting colleges and also student groups then both these methods had some relevance. The theoretical sampling approach was appropriate for the choices of student groups in response to analysis of early data but the colleges needed to be chosen in advance. In colleges the contrasting structural arrangements of dispersed and centralised staffing systems for functional mathematics might represent opposite or 'polar' types of cases and the differences due to these structures may become more prominent by retaining some similarity in other features. For this reason, it was decided to focus on two colleges with different structures but to limit the research to large colleges on the basis that communication across departments in these colleges, particularly those with multiple sites, could be very different from small colleges on single sites. A focus on colleges in urban areas was preferred to ensure that the range of student backgrounds in each college were fairly similar since colleges have wide catchment areas but densely populated urban areas may be more likely to include a similar range of socio-economic backgrounds.

In addition, it seemed appropriate to avoid colleges that were undergoing significant changes or challenges during the year such as mergers, financial difficulties or unsatisfactory Ofsted reports. These situations might limit the opportunities for the research but could also lead to unusual influences on staff and student perspectives.

Practical considerations also needed to be taken into account in selecting the colleges. In anticipation of needing to make frequent visits at different times of the day to see a range of classes it seemed reasonable to restrict the choice of colleges to those that could be reached within an hour from home by car or public transport.

3.3.2 Selecting the vocational areas and student groups

One of the key decisions was to determine the number of student groups and the vocational areas that would be used for the study. Within a case study approach a focus on cases that may be of particular interest, from which inferences can be made, is common indicating that the number of student groups to be used could be quite small. Considering these as nested case studies within the college case suggested, however, that several student groups in each college would be required to gain sufficient data for analysis at college level. My decision was to select six student groups in each college, making a total of twelve case studies at this level. In view of the pace of change and turbulence in colleges it was expected that some of the selected groups would be merged or re-timetabled or that the teacher may change during the year. This could result in several groups being withdrawn from the study but it seemed likely that three or four groups in each college could be retained through the full research period, which would span the most of the student year.

The choice of vocational areas was more problematic because of differences between departments that may have an impact on the findings. In order to make comparisons it would be best to involve student groups from the same vocational areas in each college. This would not be easy because not all colleges delivered the same courses and choosing a vocational area for the research in advance meant making an assumption that the teachers in both colleges who taught in this area would agree to participate. It was clear that this was too narrow an option and that some discussion would have to take place with college staff before a final decision could be made.

My decision was to approach each college with a short list of vocational areas for negotiation. There were three criteria that might have an influence on the student experience and needed consideration in making the selection of vocational areas:

1. Many vocational areas are gender-biased (e.g. Construction, Engineering, Hair and Beauty, Health and Social Care) and it seemed appropriate to select two vocational areas with opposite biases and one with a gender balance if possible.

2. In some vocational areas the use of mathematics was more visible and students might be more likely to see the links to their vocational course. Choosing at least one area with strong connections to mathematics and at least one with a weak association would enable some comparisons to be made.

3. Vocational courses often have a strong focus on practical skills and time is spent in a workshop (Construction, Automotive, Engineering) or a training salon (Hair and Beauty) whilst others are more classroom-based (Public Services, Health and Social Care, Business, IT). These courses may involve different approaches to learning so the decision was made to include at least one practically-based area and one classroom-based course so that students from both types of vocational programme would be involved.

Once the colleges had been identified then the options could be narrowed. Using a list of the main vocational areas from each college, those only delivered by one college could be eliminated and the remaining ones assessed against the three criteria outlined above. My decisions regarding the match of vocational areas to the criteria were checked independently by two experienced teachers to ensure the categorisation was appropriate. From the resulting list, the largest vocational areas would be preferred to traditionally small areas, such Horticulture or Animal Care, so that there would be more classes from which willing teachers and groups might be recruited.

The level of functional mathematics being studied by the students was also a factor in deciding which classes to include. At Entry Level there is less emphasis on application in unfamiliar contexts and the qualification is internally assessed but Levels 1 and 2 involve more unfamiliar contexts and are externally tested. It was decided that Level 2 vocational groups would be preferred since the majority of the students would, from previous experience, be working at functional mathematics Level 1 with perhaps a few at Entry 3 or Level 2. In this way most students would be preparing for test entry rather than internally assessed tasks. Level 3 vocational groups were not thought to be so suitable since general entry requirements are higher for these courses and more students would already have a GCSE grade C in mathematics. This may mean only a few students from a group would be taking functional mathematics and these may be incorporated into mixed vocational groups rather than being taught as a cohort.

The final criterion was to try to avoid having groups in the study taught by the same teacher unless there were distinct differences between them. This was due to reflection on the preliminary work, in which discussions took place with two student groups taught by the same teacher. The similarity in their opinions suggested that two groups with the same teacher would probably yield very similar responses and more useful data may be obtained from groups with different teachers.

3.3.3 Recording of interviews, focus groups and observations

The aims of the staff interviews were to gain understanding of their opinions and therefore audio-recording was felt to be adequate since information on gestures, facial expressions and other body language were not the primary interest for this research. Similarly, audio-recording of the focus group discussions was thought to be sufficient since students' views would largely be expressed verbally and this would be less intrusive than visual recording.

For the lesson observations, audio-visual recording would have been useful to observe and analyse classroom activity but there were two particular difficulties that influenced my decision against recording. Firstly, audio-visual or even audio recording is rarely used in Further Education colleges and student reactions were a concern. The integrity of the research depended on obtaining observations of authentic experiences and on gaining the trust of students so they would discuss their views openly in the focus groups. Subjecting them to audio-visual recording in the classroom might produce atypical behaviour and undermine early attempts to build these relationships.

Secondly the research was planned to include student groups that may well be dispersed across several college sites in different rooms of varying size. Familiarity with colleges also suggested that room changes often occur and the practical difficulty of setting up equipment quickly in variable locations could be considerable for a single researcher.

For these reasons it was decided not to use audio-visual or audio recording in lessons. Although it would add breadth and depth to the data, the loss of this additional insight was not considered crucial to a research design with a multi-method approach and the opportunity to observe lessons over a sustained period of time.

3.3.4 The timescale for data collection

The proposed timescale and order for the different elements of data collection is shown in Appendix 2.2 (page 283) but in this subsection some key decisions will be explained that contributed to this plan. The overall timescale for data collection needed to be sufficient to accommodate multiple observations of each student group across the college year, which was the normal length of a functional mathematics course in Further Education. It also needed to reflect the intended approach, in which data collection and analysis would take place concurrently and interim findings would inform further stages of data collection.

Ideally, gaining access to the colleges and conducting the interviews with managers needed to take place during the summer term, prior to the academic year in which data collection would take place. This would allow time for staff to complete the questionnaires before the autumn term so interviews could be arranged and provisional groups identified for the research early in the college year.

Responses to the questionnaires would provide information on teachers who were willing to be interviewed and indicate any particular aspects to explore further in the interviews. There would also be some early indication of possible vocational areas for the research. Selecting the vocational areas was dependent on functional mathematics teachers in suitable sections of both colleges being willing to participate, so it was important to achieve a good rate of return and sufficient options for the vocational areas in each college. Since the quietest period of the college year for staff was usually early July, just before the holiday period and team meetings were common during this period it was decided that this would be the best time to introduce the research to staff and invite them to complete questionnaires.

Starting the interviews and lesson observations early in the college year was, however, thought to be counter-productive since changes to classes and timetables are common in colleges during the first few weeks of term. Enrolment is not predictable and late applicants may be added to classes or students may change course. It is not unusual for groups to be combined or split during the early weeks and for staff timetables to be adjusted. In view of the risk of this type of disruption to teachers' early timetables it was decided to commence interviews and lesson observations in October when classes and work patterns should be more settled.

The sequence of data collection methods was an important consideration since some elements needed to precede and inform others. Functional mathematics questionnaires needed to be completed before interviews but lesson observations also needed to take place before focus groups.

Focus groups were planned for each term and the first meetings would follow after several observations of lessons for each group. This would give time for the researcher to establish relationships and for student volunteers to be recruited. It was anticipated that practical arrangements for focus group meetings would need to be negotiated for individual groups since room availability was often limited and students were unlikely to be on site when not timetabled for lessons. This would affect the timing of meetings and lead to some delays so a block of time was allocated for focus groups to allow some flexibility and space before the next stage of data collection.

The timing of the questionnaires and interviews for vocational staff was less critical. Although it was important to capture the vocational viewpoint it was not essential that these were completed early in the year. Scheduling these after the first term would allow time for any emerging issues to be incorporated into these interviews but placing them before any final discussions with the focus groups would provide an opportunity to follow up any new areas of interest with students. The main consideration was to place these at a time when it was practically feasible for staff and researcher.

3.3.5 Ethical considerations

The research was conducted in line with accepted ethical guidelines (BERA, 2011) and consent was obtained from the School of Education, University of Nottingham prior to the field work. Permission to carry out the research was formally obtained in writing from each college principal, following informal discussions with functional skills managers about the scope of the project, the research methods and the possible extent of the college's involvement. Consent was then obtained in writing from each teacher who participated in an interview or observation and from each student who contributed to a focus group. The colleges did not require individual parental consent for activities that would take place inside the college except for students under 16 years of age. Since colleges would occasionally place under 16 students into vocational groups, ages were checked prior to participation and forms were available for parental consent if required.

The main ethical considerations for the study were the confidentiality of information provided by participants and the protection of their identity. It was important to students and staff that the data would not be presented publicly or reported back to the college in any way that meant they could be identified. Normal procedures were followed such as secure storage, password-protected electronic records, anonymity of contributions and the use of pseudonyms to protect the identity of the participants. For the return of questionnaires, envelopes marked 'confidential for the researcher only' were provided to ensure confidentiality.

Any reports on the research requested by the colleges would be restricted to broad generalisations across the whole breadth of the study. The functional skills managers, however, would be aware of the staff taking part so care would be taken to check that this was understood by teachers and acceptable to them.

The researcher obtained an enhanced disclosure (CRB) through the University of Nottingham. In view of the age of the participants (under 18) safeguarding issues were relevant but risks were likely to be low for the type of research planned. The topics for discussion were not unduly sensitive, although the possibility of extreme reactions, disclosure of criminal activity or inappropriate comments to others in discussions were possibilities, in which case reporting to the college safeguarding officer may be necessary.

Information on prior attainment provided by the students themselves would be voluntary due to the sensitivity that might be associated with declaring a low grade. Other data requested from the colleges would be in the form of reports that did not include student names and could be made available in accordance with the data protection regulations.

3.4 Methods of analysis

3.4.1 General approach to analysis

The analysis of the data needed to take into account the three elements within the chosen approach to the study: mixed methods, grounded theory and case study. Using a mixed methods approach meant that both qualitative and quantitative data would need to be analysed and integrated (Onwuegbuzie & Teddlie, 2003) but the two types of data would need different treatment at the first level of analysis. For the questionnaires a quantitative approach was appropriate but the interviews, focus groups and lesson observations required a qualitative method of analysis.

The analysis of qualitative data would involve trying to make sense of complex phenomena (Yates, 2004) and would not be limited to a single way of analysing (Wellington, 2000). Huberman and Miles (2002) state that analysis can be divided into three distinct stages: data reduction, displaying the data and drawing conclusions but with a mixed method, grounded theory approach it seemed that my analysis would resemble a more ‘messy’ process. As an integral and interactive part of the research rather than a separate stage (Wellington, 2000) the analysis might be better likened to arranging, rearranging and piecing together a patchwork quilt until it resembles a single, complete unit (Denzin & Lincoln, 2003).

The grounded theory approach meant that analysis would proceed alongside data collection to identify emerging themes and inform the direction of the research. My analysis would commence once the first data had been obtained and would continue throughout the fieldwork, shaping the data collection in a dynamic process of constant comparison and interaction (Bogdan & Biklen, 1992).

Classic grounded theory normally involves a particular systematic means of analysis based on an inductive approach (Newby, 2010) which uses coding, memos, categorising and comparison to derive theory from data (Strauss & Corbin, 1998). For my study, this provided a useful set of principles and an outline framework for the analysis. Features of qualitative research such as immersing oneself in the data, standing back to reflect and taking apart the data into manageable pieces (Wellington, 2000) could be incorporated into a more structured process of coding, theming and theorising to explain patterns (Newby, 2010). By incorporating the main characteristics of theoretical sampling, coding, constant comparison and the identification of core variables (L. Cohen et al., 2007) then my analysis would have a recognised structure that would add validity to the findings.

The use of coding in qualitative analysis needed some closer examination since this would be fundamental to organising ideas and opening up the text (Newby, 2010; Richards & Morse, 2007). In a grounded theory approach three stages can be identified that would be useful to consider: substantive or open coding; selective or axial coding, in which codes are grouped together; and finally theoretical coding, in which a core idea is developed that connects the codes (Newby, 2010; Yates, 2004). My intention was to use this constant comparison method to guide the process of analysis so that, as different sections of qualitative data were gathered, they could be transcribed, coded, summarised and compared with other data whilst moving towards the development of theory. By this means, the wide and varied data from my research would be continually examined, coded, grouped and refined until theoretical ideas were established that were consistent with the data. This method of active inquiry should help to avoid the descriptive or shallow findings sometimes associated with qualitative methods (Richards & Morse, 2007) and, since grounded theory is “not averse to quantitative methods” (L. Cohen et al., 2007, p.491), both qualitative and quantitative data could be incorporated.

The methods of analysis associated with grounded theory were suitable for the theory-seeking nature of my research but these needed to be compatible with the case study approach. Eisenhardt (1989) suggests that, with case studies, a similar, iterative approach is suitable for building theory in stages of divergence as data is compared and explored, but within an overall aim of achieving convergence into a single theoretical framework. Data collection and analysis may also overlap in a case study approach and there is a similar expectation that closure will occur when theoretical saturation is reached (Eisenhardt, 1989).

The distinctive features of case study analysis of value for my study were the opportunities for ‘within-case’ analysis and ‘cross-case’ comparisons. This would be a productive means of using the cases to develop further understanding and test emerging theory. ‘Within-case’ analysis would focus on each case as a separate entity with its own patterns, whilst ‘cross-case’ comparisons could be used to search for broader patterns, similarities and core themes.

These grounded theory and case study approaches to analysis each contribute to the overall plan in a complementary way and involve the interaction of analysis with data collection (Bogdan & Biklen, 1992). With the possibility of constraints on additional fieldwork then it seemed that iterations between data collection and analysis may need to be planned in phases so there was time to negotiate any changes to the original plan with colleges. There was also a risk that theoretical saturation may not be achieved within the time period agreed and this was a possible obstacle that would need resolving by negotiation with colleges if necessary or the limitations may be reflected in the findings.

3.4.2 Outline plan for analysis

The interaction between analysis and data collection made it difficult to prepare a precise plan and flexibility was needed since additional data collection or cases may be needed as the research progressed. The following stages of data collection provide an initial chronological framework into which the analysis would be integrated:

- Interviews with managers
- Questionnaires for functional mathematics teachers
- Interviews with functional mathematics teachers
- First round of lesson observations
- Individual student activity

- First focus group meetings
- Second round of lesson observations
- Questionnaires for vocational teachers
- Interviews with vocational tutors
- Additional observations, interviews or focus groups.

As the data from one element of this framework was obtained for a single college, then a first level analysis would be carried out. For interviews and focus groups this would entail full transcripts and initial open coding to elicit the main themes. Once a full set of data for an item had been collected from all the colleges then further analysis and comparisons could take place.

The questionnaire data would be coded numerically, using nominal codes for descriptive categories, such as gender and department. Numerical codes for responses on the Likert scale would be regarded as ordinal rather than interval. This data would then be entered into a spreadsheet and summarised so the key features or trends could be identified. A written summary of the results would be prepared and used to inform the on-going data collection, particularly the areas to be explored in the interviews. A similar method would be used for responses to the student card-sorting activity. With a full set of questionnaires from functional mathematics staff then a cross-college summary could be constructed so overall trends, similarities and differences could be examined. Some further analysis may be possible at this stage using SPSS but since the data would be mainly ordinal and the numbers of responses would be relatively small, then statistical methods would be restricted to simple non-parametric tests appropriate for the size of the data set.

As interview and focus group data were gathered, transcribed and coded, then these open codes would be grouped into categories so the emerging themes could be identified. Using NVivo for the storage and coding of qualitative data would make the process easier to handle since it was anticipated that the volume of qualitative data would be substantial.

In some sections of the data there were specific comparisons that would be of interest. For example, comparing the responses of students to the same statements about school and college mathematics or comparing the questionnaire responses of vocational staff to functional mathematics staff. These would be important in identifying key differences or similarities and would need incorporating once the relevant data sets were complete.

In this way analysis would move forward whilst also feeding back into the data collection to ensure gaps were filled and additional data gathered, where appropriate. Meanwhile the case studies of colleges and student groups would be developing, based on early interviews and lesson observations but continually being refined as additional data was analysed, compared and incorporated.

3.5 Implementing the research plan

3.5.1 Selecting the colleges and student groups

During the preliminary study, informal visits were made to three colleges and four different sites. Two of these colleges seemed suitable for the main study since they met the criteria for the research of being large colleges in urban areas, one having a dispersed structure whilst the other had a centralised team. The initial indications were that these colleges would both be interested in further involvement but when approaches were made then one college confirmed their interest but the other decided to decline the opportunity.

A formal request was made to the college principal of the interested college (College B). This was an organisation with a well-established dispersed staffing structure for functional skills so further efforts were then made to identify a suitable college with a centralised staffing structure to accompany this. Two colleges were approached with a view to arranging an exploratory meeting and both colleges responded positively but neither exactly fitted the centralised model that was needed to work alongside the distributed structure of College B. One college had been using a centralised structure and was moving to a distributed structure. The other had a centralised arrangement but there were departmental variations that made it resemble a more hybrid structure in practice. It was considered, however, that either of these colleges could make a useful contribution to the research since one had both centralised and dispersed features and the other could provide some valuable insight from staff as they moved through the transition between structures. The decision was made to formally approach both colleges, because at this point acceptance was not guaranteed, and having a college in reserve may be a wise precaution. Colleges were subject to rapid changes and unexpected circumstances could arise that may limit their involvement or cause them to withdraw from the research. The reserve college could be used, if necessary, for:

- further pilot work
- additional case studies (if one college had insufficient teachers willing to participate in suitable vocational areas)
- replacement of one of the other colleges should they have to withdraw.

All three colleges were expecting Ofsted inspections during the year in which the research was planned so some delays or missed opportunities might arise, depending on the timing and scope of these inspections. In fact, two of the colleges did receive inspection visits but these did not seriously affect the data collection.

Formal requests to the colleges did not lead to prompt responses and some follow up was needed before confirmation was provided by all three organisations that they would participate. In each college the functional skills manager, with whom some discussion had already taken place, was identified as the main link.

3.5.2 Data collection

In this section some of the difficulties of implementing the data collection plan will be described and the decisions that were made in response to these problems. This serves to illustrate the 'messy' nature of the research and the flexibility required in the process to accommodate the challenges presented. A summary of the questionnaire responses can be found in Appendix 3.1 (page 286) and the student responses to the card-sorting activities are summarised in Appendix 3.2 (page 288). A time plan showing the actual implementation is included in Appendix 2.3 (page 284).

Interviews with managers

It was important to interview the functional skills managers in June or early July so that plans were in place for the following academic year but arranging these meetings proved difficult in two of the colleges due to the managers' limited availability and work pressures. As a result, the functional skills manager interview at College A took place in early July as planned, the interview at College B was postponed until later in July and an initial meeting finally took place for College C in mid-September, with the actual interview following in October.

Functional mathematics staff questionnaires

In the proposed timescale an opportunity had been identified for functional mathematics staff to complete the questionnaires in July when teachers were mainly occupied with planning and professional development rather than teaching. With delays to the manager interviews this opportunity was lost at Colleges B and C so only College A was able to deal with the questionnaires in the summer period. The preferred method for completion, during a staff team meeting, was not feasible since cross college functional mathematics meetings were infrequent and attendance was usually poor. After some discussion of alternative methods the questionnaires were distributed in envelopes through the college internal mail with a return label and the manager used emails to personally encourage staff to complete these. Although 46 questionnaires were sent out there was some doubt about how many of these staff had been actually teaching functional mathematics in the relevant year (2011/12). Despite further questions at a later date there was no clearer indication of the exact number so a figure of 40 was estimated. Subsequent visits to college departments would suggest that this was probably an over-estimate.

In College B teachers were already on their summer break by the time the manager interview took place but an offer was made to complete the questionnaires at a meeting during the first week in September. Whether this was overlooked or whether the meeting did not take place was unclear but the questionnaires were not completed and, after some email reminders, they were distributed via the internal mail in late September.

At College C, following the initial meeting in mid-September, a date for the manager interview and a staff meeting for completion of the questionnaires were promptly arranged for late September. These meetings were later postponed to October for practical reasons beyond the manager's control. Several staff attended the rearranged meeting, completed questionnaires, showed interest in the research and volunteered to be involved. Those not able to attend were contacted directly by the functional skills manager and asked to complete questionnaires.

In each college, further returns were obtained as the research progressed and the overall return rate for the questionnaires was eventually 51 % (39 out of 77 possible returns) but this was unequal across the colleges (College A: 17 out of an estimated 40; College B: 13 out of 27; College C: 9 out of 10).

Interviews with functional mathematics teachers

Functional mathematics teachers were asked to indicate at the end of the questionnaire if they would be willing to take part in an interview and on the basis of these responses it was hoped to identify a sample of staff to interview, some of whom would be invited to take part in the rest of the research. The vocational areas for the research would remain flexible until all the questionnaire responses had been received and interviews had commenced so possible areas could be identified in all three colleges. The initial intention was to recruit teachers and their groups from similar areas in two of the colleges for the case studies. This was not a simple process and was further complicated by all three colleges being at different stages with the questionnaires. College A had completed these but there were delays with Colleges B and C. Although College B was still the preferred choice for the research there was some uncertainty whether this college would actually proceed any further and, therefore, whether College C would be a better choice.

To avoid further delays, interviews commenced at College A before questionnaires had been completed at Colleges B and C. Some provisional vocational areas had been identified from the returns and the functional skills manager checked timetables to identify additional teachers who may not have completed questionnaires but might participate if approached directly. The experience, gender and college roles of staff (specialist or vocational, central team or dispersed) were monitored as the interviews progressed to ensure there was representation from each of these categories. As this process continued at College A, it was eventually possible to see whether the other colleges could provide groups for the same vocational areas or not.

The delay with questionnaires at College B, and indications from the manager that some vocational areas would not be willing to participate, meant that College C was asked to participate fully in the research. In this college there were policy decisions that directed certain student groups to take a particular functional skill and this meant that in some vocational areas there were no Level 2 students taking functional mathematics that year. In addition, there were missing questionnaires from staff with key roles since they were the only functional mathematics teachers in vocational areas of potential interest for the research. With the assistance of the functional skills manager, progress was eventually made and interviews commenced. At the same time questionnaires were forthcoming from College B and a decision was made to include all three colleges since it now seemed likely that three suitable vocational areas (Hair and Beauty, Public Services and Construction) could each be represented at two different colleges but not at all three. The likelihood of one of the colleges withdrawing from the research also remained high.

As the interviews progressed, some functional mathematics teachers identified other staff that were teaching in the chosen areas and might be willing to participate. These suggestions were followed up and in this way it was eventually possible to find groups for each vocational area at all three colleges. Despite the increase in the number of research groups, (from 12 to 17), it was decided to include all these at this stage since this served to enrich the study. It was also anticipated that the number would reduce during the year since changes to timetables, staffing and student attendance were common occurrences in colleges that could result in some groups no longer being able to take part.

Due to the extended period of uncertainty about which vocational areas would be participating in the research, more interviews were carried out than originally planned, firstly to explore different possibilities and then to complete interviews for all the teachers of the selected case study groups. All the functional mathematics teachers except one were eventually interviewed by the end of the first term. Most of the focus groups and planned lesson observations were also completed at this stage but, for groups who were late additions from College B, it was not possible to complete the lesson observations and focus groups until early January. At this point lesson observations also commenced for two groups from College A whose functional mathematics courses did not actually start until January.

Student groups selected for the research

The original intention of selecting three vocational areas in each college for the study was achieved by using the Public Services, Hair and Beauty and Construction areas but these included some variations that were included for particular reasons:

- A Public Services course with an emphasis on preparing students for employment in Emergency Care was used in preference to a second general Public Services course with the same tutor.
- A Level 1 Beauty Therapy course was included since there was only one Level 2 Hair or Beauty group taking functional mathematics in this college.
- A Forensic Science course was used as an alternative to Public Services in one college rather another Public Services course with the same tutor.

When identifying student groups to participate in the research, requests were made to teachers to offer some of their more challenging groups rather than just the ones that worked well. Some teachers responded to this and offered groups that they found difficult in some way. Also, three teachers who were the sole functional mathematics teachers for their areas offered two groups each and these were included in the research since they were able to identify distinct differences between the groups. The final selection of case study groups and their distinctive features is shown in Appendix 2.4 (page 285).

Lesson observations

Although lesson observation dates were arranged directly with teachers there were frequent disruptions and changes to arrangements. Rooms were sometimes changed at short notice and on two occasions it was necessary to search around the college for the class since they were not in their timetabled room. Several times functional mathematics teachers had to change rooms because the ones scheduled were occupied when they arrived. Public Services students, in particular, had frequent timetable changes, sometimes to a different site. One course was moved to the local Territorial Army Centre and my visits were postponed since access to the site was denied for civilians and it was uncertain whether special arrangements could be made. There were also cancellations of scheduled observations due to staff illness, a college strike, bad weather, student trips, expeditions or examinations. Since functional mathematics lessons for each group were only held once a week this meant a delay of at least a week for every cancellation.

The schedule for the lesson observations in the first term was complicated by the staggered start and therefore opportunities were taken to observe lessons at the first possible availability. This involved working in all three colleges concurrently, with extensive travelling between sites. Where possible, classes at exactly the same time of the week in the same college were avoided so that in the following term the college visits could be planned into neat blocks involving one college at a time. In the second term, apart from some delayed observations due to cancellations, it was possible to concentrate largely on one college at a time for a two-week period with a one-week break between these blocks of visits to accommodate delays. This provided a more manageable schedule with valuable space for completing transcripts and interim analysis.

Third term observations were finally removed from the plan for two reasons. Most lessons in the third term were focussed on revision and in some groups students were no longer required to attend since they had already taken and passed their functional mathematics examination. For the purposes of this research, it was felt that a virtual ‘saturation point’ had been reached and that further observations of lessons, which were mainly revision sessions and often sparsely attended, would not add significantly to the findings.

Student focus groups

The main challenges of implementing the plan for the focus groups were the practical arrangements for the meetings and the recruiting of students. Practical arrangements varied between colleges and groups. Some functional mathematics teachers offered part of their own teaching session for the first focus group and assisted in finding a suitable room nearby for the discussion. For other groups, where teachers were less keen to sacrifice teaching time, then the vocational personal tutor was approached to see if time could be found during tutorials or practical sessions. The vocational tutors were supportive in identifying suitable times when students could be released but in most cases it was expected that the researcher would take responsibility for finding a suitable room for the focus group. Systems for room bookings varied widely between college sites and were generally inaccessible for anyone except staff members. It took a considerable amount of time and effort to navigate these systems and in some cases the 'opportunist' approach was rather more effective than the official booking system. Teachers often seemed unaware of bookings and on several occasions focus group meetings were interrupted by staff entering rooms to collect materials or to prepare the room for a following lesson, even when a booking had been made. Sometimes there seemed to be no better alternative to walking the corridors just prior to the focus group meeting in order to find a vacant space.

Room availability was a major problem in colleges and sometimes it was difficult to locate a suitable room at all at the time the students could meet without a long walk to the opposite side of a college site. Some rooms had insufficient chairs or no tables (which were needed for the individual activities) but the students adapted to conditions that were not ideal but sometimes unavoidable. One focus group meeting took place in a small vestibule adjacent to the hairdressing training salon whilst another took place in a tiny office because there were no other rooms available on the site at the time. One of the final focus groups for a Public Services group took place during a practical session held in a public park whilst sitting on the grass at a distance from the other students. Several discussions took place within hairdressing training salons because this was the only available space that could be found. Fortunately these salons were large enough to conduct a discussion at one end of the salon without being overheard by the teacher or other students above the noise of the hair-driers and salon music.

Recruitment into the first few focus groups took place initially by asking for volunteers in the classroom situation but this proved unreliable. Students were, understandably, wary of an unknown activity and generally unwilling to use their own 'free' time for a meeting. Once the pattern was established of using a timetabled college session for the meetings then the students were less reluctant. Both functional mathematics teachers and vocational tutors were supportive in encouraging students to join the focus group and a few actually selected the participants, although these students were still required to provide individual consent before being included.

The focus of the research was on students aged 16-19 but some mixed-age vocational groups were unavoidable due to college policy and so some mature students were present in a few classes. It was decided not to include mature students in the focus groups unless insufficient younger students were available.

In their discussions some groups proved to be more responsive and talkative than others. Prompts and additional questions from the researcher were sometimes required to sustain any discussion whilst other groups talked freely, occasionally deviating from the topic but requiring less intervention. The Construction groups were often less forthcoming in discussion than the Hairdressing and Public Services students but this tended to be consistent with their behaviour in lessons and with comments from teachers about their general reticence.

In the second term student absences affected the size of some focus groups and a few of the original students had actually changed course or left the college. In these situations other students volunteered as 'substitutes' to ensure there were at least four students in each discussion. In view of the quietness of some groups it was decided that this was an appropriate minimum number to facilitate a discussion and it was better to have a viable session with some new students present than to preserve consistency.

In the final focus group discussions, however, it was important to have as many of the original students present so that comparisons could be made between the attitudes shown in first term activity and those indicated by a repetition of the same activity. Student absences meant this was not completely achieved although 73 of the original 103 students were involved in the third term discussions.

Vocational interviews and questionnaires

In the original time scale, the vocational staff questionnaires and interviews were due to commence in December but delays with other parts of the fieldwork meant that completing these at the time proposed was impractical and these were postponed to later in the second term. The grounded theory approach led to a research design that had an emerging shape rather than a set plan for the second and third terms so this was not a problem. Reflections on the first term suggested that the initial comparative study between colleges was revealing more similarities between vocational areas in different colleges than between departments in the same college. This seemed to be due to the devolved responsibilities and policies of colleges but shifted the research focus towards the case studies of student groups rather than college cases.

The new emphasis on the student group as the main unit of analysis influenced the choice of vocational staff for completing questionnaires and interviews, since a college-wide approach was no longer necessary. It was decided that one member of staff would be interviewed for each separate vocational area or team in which there was a case study group. A teaching member of staff who was familiar with the student group, such as the personal tutor, would be preferred so that reference could be made to the specific group rather than simply generalisations about students.

The order of data collection in vocational areas varied at this point. During the second term, the relevant vocational team leader or head of department, depending on the structure in the college, was approached for permission to distribute the questionnaires to staff. Practical arrangements were made with these managers who sometimes also suggested vocational teachers who would be appropriate to be interviewed. In other cases, the personal tutor was already a familiar figure to the researcher and a direct approach was made, with the questionnaires by the team following later. This stage of data collection was particularly messy since college structures and practices varied. In some departments, responsibilities were devolved and team leaders or individual teachers would take personal decisions regarding their involvement in interviews but in other cases they would be expected to consult with the head of department prior to taking part. There seemed to be no consistency in working practices and individual arrangements had to be made.

The rate of return of vocational questionnaires varied considerably. In total, 38 questionnaires were completed from the 14 vocational teams involved, with some representation from every team but a very uneven spread. Although the preferred method of distribution and return was through a team meeting, managers sometimes decided to use their own methods, with varying degrees of success. Completed returns were often gathered together by the manager and arrangements made to collect these in person, as requested by the researcher, but even this proved unreliable. One set of completed questionnaires was lost completely when left in a named envelope at reception for collection at my next visit. Despite strenuous efforts to locate these across the entire college they were never found. In another college a set of completed questionnaires were misplaced when the staffroom was relocated but, in this case, the team offered to repeat the questionnaire rather than losing the data. The difficulties of being an unfamiliar person in a large organisation were apparent and relying on personal contacts made through visits was inconvenient but necessary. This dependency on a large number of individual college staff produced some very variable outcomes.

Finding time and rooms for interviews in busy staff timetables was difficult and meant separate visits to each college were often made for single meetings rather than being able to co-ordinate these with other visits. Interviewees were helpful in finding rooms although these were not always ideal. Some interviews took place during practical workshop sessions in attached offices, from which the vocational tutor could maintain visual contact with the students as they worked. Two interviews had to take place in open-plan areas where other staff members occasionally passed by and confidentiality could only be preserved by speaking quietly or pausing temporarily.

Vocational observations

Informal observations of vocational sessions were added to the schedule in response to the data collection and analysis from the first term. These observations were informal but provided an opportunity to compare students’ responses to a vocational learning situation with my observations of functional mathematics lessons. Any naturally-occurring uses of mathematics in these vocational situations or links to functional mathematics were also noted.

These observations mainly took place in the second term but, again, delays meant a few were postponed until the third term. Requests were made to the team leader, or to the personal tutor, who would suggest possible sessions to observe. Changes to student timetables were frequent, particularly for Public Services students, and communication was not always easy. On one occasion arrangements were made by vocational staff for an observation but on arrival it became apparent that this was the wrong group and a second visit had to be arranged. For other visits there were late changes to arrangements but, despite these obstacles, it was possible to observe each group in a vocational session before the end of the data collection period.

Collecting college and student data

The collection of college data was planned well in advance and a list of data reports prepared that would be useful for the study. The specification for these data reports was discussed with one of the colleges prior to making any formal requests to ensure these were accurate descriptions of reports that could be easily extracted from a college data system.

Minor adaptations were made before requesting the data from each college. College responses varied and the data provided was inconsistent, with one only college providing the exact reports requested, even after offering further guidance. One college failed to provide the correct reports even after two attempts whilst the other only supplied part of the data. This was a disappointing response to a request that had been tested and checked for feasibility before use. As a result, the college data had limited value for the research and served only to provide some background for the study. As the research progressed, however, it was clear that departmental policies significantly influenced the numbers of students taking functional mathematics and the level of examination entry. Any comparison of participation or success rates across colleges from this data would therefore have little credibility due to the effects of these variable policies.

Data on the prior achievement and examination entries of individual students was gathered directly from the students in the focus groups rather than via the college. This strategy was successful although the data was incomplete because some students seemed unable to recall their GCSE grades and a few were uncertain about the level of the functional mathematics examination they had taken or would be sitting before the end of the year.

3.5.3 Development of the research plan in response to early findings

The approach to the research involved concurrent data collection and analysis with on-going interaction between the two. At the end of the first term, the space between college terms provided a break from activity in the colleges sufficient for a thorough review of progress with data collection and analysis before finalising plans for the following term.

At this point the questionnaires had been completed by functional mathematics teachers and sufficient student groups had been identified as case studies. Most student groups had been observed on at least one occasion, although two or three observations would have been preferred and some focus groups had not yet been able to meet. It was decided to extend the first phase of observations and focus groups into January so all the groups could become viable case studies. This meant that data collection planned for the second term would not commence until late January. In addition, it had been planned to include two new Construction groups that would start their courses in late January since, at this college, these students only attended functional mathematics for half the year (with double length sessions) and it had seemed more appropriate to use this new cohort for the research rather than one that finished in early January.

A cycle of visits was planned for the rest of the term so that each student group would be observed in their functional mathematics sessions for a further two lessons. The focus for these observations was determined by the interim analysis that highlighted two areas for further exploration: student responses to different teaching and learning approaches and student perceptions of relevance.

Data from the first term provided some evidence of the teaching methods being used but there was a need to gain deeper insight into students' responses to different teaching approaches and perceptions of relevance in order to answer the research questions. It was decided that observations of functional mathematics lessons would focus on student responses but the functional aspects of the lesson and any contexts used for tasks would be of particular interest. An observation record sheet was designed to facilitate the focus on these aspects.

Secondly, as already described, it was decided to include some observations of student groups in their vocational sessions to gain a better understanding of how they learned and responded in vocational sessions compared to functional mathematics classes. Each group would be observed once in a vocational session and this would also provide an opportunity to identify uses of mathematics in their vocational courses.

Finally, the emphasis for the next round of focus group discussions would be on exploring students' views of a set of contextualised tasks. A bank of suitable tasks was put together, using examples of tasks in different contexts from lessons already observed. Samples of these tasks can be found in Appendix 1.9 (page 277) and a full list in Appendix 1.8 (page 276). Three tasks for each group would be selected from the bank and used as prompt materials for discussion. These would have some possible relevance to the students' particular vocational area or personal interests but none would be tasks they had already used in classes. Responses from different groups to the same task could then be compared to identify differences and reasons for their perceptions of the context and relevance.

At the end of the second term a further review of data collection and analysis took place. Despite one functional mathematics teacher leaving and one moving to a different position within their college, all seventeen student groups were still actively involved in the research. Although no further lesson observations were considered necessary, it was decided that the third round of focus groups would still be useful to explore the overall student impressions of their functional mathematics course and the outcomes of their learning experience. The focus group meeting would also provide the opportunity to repeat part of the card-sorting activity used in the first term to ascertain whether attitudes were consistent with early indications and also to obtain information about student examination entries or achievement.

The process of data analysis broadly followed the initial plan but some sections of the data contributed more strongly to the findings than others. There are a number of points that are relevant to the implementation of the research and will be mentioned at this stage.

Firstly, the ordinal data from student comparisons of school and college showed some differences but, due to the small numbers in some categories, it was not considered appropriate to use a chi-squared test for significance. Instead the differences in ratings given by each individual for different statements were calculated and the sign test was used. This confirmed that there were significance differences for several categories, as shown in Appendix 3.4 (page 285) and this made an important contribution to the analysis when triangulated with qualitative data from focus groups and lesson observations.

Initial comparisons of questionnaire responses from vocational and functional mathematics teachers indicated no particular differences of significance for the study and further statistical analysis was not considered necessary. Teachers' questionnaire statements about the meaning of functional mathematics were examined for word frequency and this proved useful to compare with interview and lesson observation data. As the research developed it became clear that qualitative data was dominant and the level of integration with the quantitative data meant the research should be considered as a multi-method rather than a mixed methods study.

3.5.4 Conclusions on the 'messiness' of research in Further Education

Further Education colleges are subject to frequent changes regarding funding levels, priorities, courses offered, qualifications available and student numbers. These variations contribute to a continual need to adapt in an environment of unpredictability and turbulence. This makes the environment a difficult situation in which to conduct extended research and this study highlighted some of the challenges that researchers may face.

Colleges are large organisations with complex structures and devolved responsibilities. Implementing a consistent approach across a whole college is challenging and trying to maintain consistency in the research across the three colleges was difficult. The experiences described in the previous sections illustrate the type of difficulties involved and the secondary strategies that had to be employed. Variations in systems and working practices meant arrangements often had to be made on an individual basis. There was unpredictability about the best practical means of achieving the intended outcome, even within the same college, and a reliance on a wide range of individuals to assist with arrangements.

Planned approaches often had to be adapted and supplemented by other methods to be effective. For example, identifying the functional mathematics teachers who would be willing to participate was not possible on the basis of the questionnaires alone. Support from the functional skills manager and personal requests or recommendations from other teachers were necessary to achieve access to a suitable set of research groups across the three colleges. In many instances the process depended on personal requests rather than on the use of a single main contact in the organisation.

Communication and coordination were particularly problematic and arrangements for visits usually had to be made with individuals by the researcher. Once the groups had been identified the key contacts became the functional mathematics teachers. Throughout the research, communication in person was consistently more effective than email because these seemed to be easily overlooked amongst the many competing demands on teachers' time. Phone calls were generally unproductive since teachers were usually in classrooms and had extended timetables with few predictable desk-based periods. Making arrangements in person during one college visit for the next one proved far more effective.

As the year progressed and my familiarity with the colleges increased then communication became easier. Security rules prevented visitors from unaccompanied access to college buildings but reception staff seemed to become more relaxed about access for a frequent visitor. Being allowed some freedom of access to the college and knowing the location of the relevant staff rooms meant that informal visits could be made to see staff about practical arrangements when on site for another lesson or interview. This proved to be a more successful strategy, although some teachers still proved difficult to contact and special visits were occasionally made to sites simply to arrange the next interview or lesson observation.

Pursuing the research in these colleges required time, effort and determination in order to maintain contact and make progress with the different elements of the plan. Despite the practical difficulties, it was eventually possible to complete a full set of data for each student group which in each case consisted of a functional mathematics teacher interview, a vocational tutor interview, three focus group meetings, an observation of a vocational session and several observations of functional mathematics sessions.

Chapter 4: The main case studies

In Chapters 4 and 5 the analysis of data from the research will be presented to show the main themes that emerged from the study. Chapter 4 will focus on within-case analysis of three particular case studies to identify significant features before cross-case analysis is used in Chapter 5 to compare themes across the full width of the study. The findings will then be linked to the literature and discussed further in Chapter 6.

Within these chapters several aspects emerge as important factors for consideration in relation to the student experience of learning functional mathematics and the specific research questions for the study. The background of students and the *effect of prior experiences* of learning mathematics will be explored to show how existing *attitudes and attainment* had an impact on their initial responses to taking a functional mathematics course. Changes associated with their *transition to college* will be examined to identify the significant elements of *college structures, polices and culture* that affected their learning experience. Finally a consideration of the *teaching approaches* used in functional mathematics classrooms and *interpretations of the functional curriculum* will show how socio-cultural influences were important and how contrasts to school mathematics lessons provided new opportunities for students with a positive impact on learning. Within this multi-level examination of the student experience there will be an emphasis on understanding students' perceptions and therefore a reliance on student data from the case studies will be apparent, although there was triangulation and synthesis with other sources.

The three case studies used in this chapter have been selected since their individual features combine to cover many of the key themes that emerged across the seventeen cases examined. Early indications from the individual student activity and focus groups suggested that there were significant improvements in student attitudes and engagement in some functional mathematics groups whilst others remained unchanged (see Appendix 3.3, page 285). This led to some categorising of student groups into those with positive attitude changes, those that demonstrated negative attitudes and those with mixed responses as shown in Appendix 2.4 (page 285). The cases selected for examination in this chapter include one group from each of these categories whilst also covering a range of other significant features including:

- policies regarding which students should take a functional mathematics course (students with grade C in GCSE mathematics being exempt and not exempt)
- teachers from different staffing structures (dispersed or centralised)

- groups with different age groups (school-leavers only or mixed, with some mature students present)
- groups with gender-bias (male or female dominated).

The cases selected are taken from just two colleges and two vocational areas, although each at a different college site. Despite these similarities these were considered sufficient and appropriate to present most of the key features that were identified across the full set of case studies. Within the extracts from focus group discussions, my own name, Diane, is used for the researcher to avoid the impression of formality and reflect the style of discussion encouraged with students.

4.1 Case Studies of Functional Mathematics Groups: Public Services with Lindsay

This case study involves a Level 2 Public Services group of students that were being prepared for a career in the armed forces, the police service, the fire services or the emergency care service. The group was typical in the sense that they had positive views of their experience in college compared to school and this reflected the overall results from focus groups in the study (see Appendix 3.4, page 285). This was a group in which considerable changes in attitudes had occurred and therefore the influences on these students and possible reasons for this transformation were of particular interest.

4.1.1 Introduction to the student group and their teacher

Their teacher, Lindsay, had taught for several years in Further Education, firstly as a Key Skills teacher and then as a functional skills teacher. She was part of a central team and specialised in teaching functional mathematics across various vocational areas on different college sites. Before teaching she had worked in retail and it was her experience as an NVQ assessor that had led to an interest in teaching. She chose to teach mathematics because it was a subject she liked and had studied to A level. She was an enthusiastic and energetic person with a ready smile, able to sustain a calm and cheerful exterior throughout every lesson despite the challenges of the group who proved to be lively, talkative and, on occasions, quite a test for her patience.

The first observation of these students took place in mid-October and Lindsay was late for the first lesson due to a problem printing the resources. This was compounded by working on an unfamiliar site and having only the lunch break to travel several miles between classes. Some of the difficulties of being part of a central servicing team that worked across sites were immediately apparent. In the following observed sessions there were often late room changes made by the vocational team and several lessons were cancelled to accommodate vocational visits or examinations. Lindsay was clearly an 'outsider' to the vocational team. Furthermore, her smart but casual appearance in leggings and city shorts matched her general business-like approach but with a group of students who were mainly male and wearing Public Services sports shirts she was clearly not 'one of the lads'.

Whilst waiting for the lesson the group chatted informally outside the room, mentioning the American presidential election, about which they seemed to know very little and the best deals in mobile phones, about which they were well-informed. Their first reactions to being included in the research were "You don't want to see us. It will just upset you!" which indicated that there may be something untraditional about their functional mathematics lessons. Including them in the study provided an opportunity to gain some insight into the views of a class who did not, perhaps, conform to the accepted norms of classroom learning.

Lindsay's first action was to rearrange the classroom tables into a large 'horseshoe' arrangement so the students were all facing inwards. She remained inside the 'horseshoe' throughout the lesson, maintaining eye contact with every student but making group work and discussion between students difficult. The students were not inhibited and simply shouted across the horseshoe if they wanted to talk to someone at the other side. The arrangement allowed Lindsay to take a position in which she was the natural focus of attention and could easily interact with each student visually and verbally. This was an effective means of maintaining control over a lively group of students but did restrict the opportunities for working in groups. In Lindsay's interview she had expressed some concerns about being able to relate to this group of students. Developing strong positive relationships with students appeared to be one of her priorities and the lesson observations provided evidence that this was the case.

A small group of students arrived very late for the lesson and were clearly excited about an incident outside college that had caused their delay. This was disruptive to the lesson but Lindsay seemed able to minimise the negative effect without adopting an authoritarian stance. She calmly questioned them about their lateness, listened to their explanation, engaged in a brief discussion about the incident and allowed them some 'space' before settling them down to work. Her non-confrontational approach seemed to have the desired effect and the group co-operated despite some animated exchanges between individuals.

The initial task for the students was about the cost of smoking and, in a discussion that preceded the mathematical calculations, Lindsay had no hesitation in asking the smokers present to identify themselves. After helping the students work out the cost of smoking over several years she was keen to point out not only the savings they could make if they stopped but the accompanying health benefits. The students related well to the topic and engaged in some lively discussion which went well beyond the mathematical task but this clearly captured their interest. The combination of mathematics with a topic that related to their lives, coupled with the use of wider discussion around the subject, was a characteristic of Lindsay's lessons that appeared to be effective in engaging the students.

The task about smoking was quite structured and involved closed questions, each with only one 'right answer'. This was surprising considering that Lindsay had talked about problem-solving in her interview and there not being 'a right answer' any more in a functional approach. The use of closed questions proved to be common practice in her lessons despite stating her interview that she believed teaching functional mathematics involved using open-ended problems. She did, however, also explain how her own love of mathematics was based on the "neatness" and "getting the right answer" and these values still seemed to influence her teaching.

During the lesson Lindsay used a variety of resources such as individual worksheets, a PowerPoint presentation and questions in a quiz format. The mathematical content was focussed on reading, writing and approximating large numbers, which seemed to be well within the students' capabilities. Some questions were in a context that might be meaningful for the students and some were not. Lindsay herself talked frequently throughout the lesson to explain, instruct, encourage or simply respond to any remarks by students. This was used as a means of engaging and sustaining interest whilst also supporting individuals who needed help. The students talked continuously but not always about mathematics. Lindsay seemed happy to talk with them, even when the subject was not mathematics and used these opportunities to build relationships.

The concentration and engagement of individuals seemed to vary through the session. A few students worked steadily through every task. Some were able to chat and complete the work with apparently little effort, suggesting it was insufficiently challenging. Others had short bouts of activity interspersed with long distractions, such as reading mobile phone messages that meant they missed vital information or failed to complete a section of the work. Despite this lack of consistent effort there was a respect for Lindsay and the students co-operated when requested to do so. The students just seemed to need frequent individual attention to maintain concentration.

There were several aspects of this lesson that were particularly interesting and discussions with the focus group were used to explore these further. The focus group consisted of five male students and one female, which reflected the gender balance in the class. Four of these students had achieved GCSE mathematics grade E at school and two had achieved a grade C but it was the policy of the college department for the entire group to take functional mathematics regardless of their GCSE grade. The influence of college policies on the student experience will be dealt with more comprehensively in Section 5.2.3 but it is worth noting here that prior attainment did have some effect on their initial attitudes to taking a mathematics course in college. There were two strong themes in the focus group discussions and these will be explained in the following sections.

4.1.2 Changing attitudes and relationships

In the first focus group meeting the students described the changes in their transition from school to college. They explained how the general college culture was very different from school and valued two aspects in particular which were described as “You get treated like adults” and “You get more freedom than in school”. These perceptions were explained using various examples, such as this one provided by Ryan.

> It’s not like … I mean we can have freedom. I mean like we can walk into the lesson and like have a can of Coke and have our earphones in and not just be like children … (Ryan)

The more relaxed rules about some aspects of college life gave the impression of freedom compared to school. This was important to students since it represented progress from childhood to adult life and independence.

Lindsay seemed to understand the values associated with this type of college culture and incorporated them into her approach. She retained a rather teacher-centred style and a position of authority but allowed the students some freedom to talk, discuss and sometimes deviate from the task in hand. For example, Lindsay often directed students to individual work but allowed informal discussion to take place in small groups. Group working, despite the constraints of the classroom arrangement, appeared to be an accepted norm of the classroom culture rather than a deliberate strategy for learning. Although the general framework for the lesson was carefully planned and executed there remained a flexibility for students to work and talk in social groups.

This combination of structure and flexibility was not dissimilar to the balance between the strict rules and 'controlled' freedom associated with a Public Services course. One of the vocational teachers explained in his interview how careers in this area, such as the armed services, require discipline and conformity but personal character development is also important. Observations of the vocational programme showed some tension between enforcing a strict code of conduct that resembled a military regime and allowing students some responsibility to take decisions as part of their personal development. Lindsay's approach had some similarities and the students responded well.

The students also described how they appreciated the variety and range of activities on their vocational course compared to school.

> Like the thing about college is instead of just coming in like at school - you just come in and sit down and do your lesson. They actually take us out a lot more, regularly, like to go on walks and expeditions.
>
> (Lee, Public Services)

In this respect functional mathematics lessons and the Public Services course were very different. There was a contrast between the varied and active Public Services course and classroom-based mathematics lessons that was evident in the observations of students in both types of lesson. This difference in activities set functional mathematics sessions apart from the students' main programme even though the underpinning social culture was similar.

The students explained how the change in their social environment was a new and exciting experience but involved social adjustments that were not always easy as they struggled to establish their identity within a group that spend a lot of time together in college.

Ryan:	'Cos college's like, everyone gets really excited over college when they first come because of the new environment and stuff. It's like quite cool basically.
Diane:	So what's different then? What do you get excited about in this new environment?
Tammy:	New people.
Ryan:	I've made a lot of new friends now and that … and it's like quality.

Lee:	Yeah. None of us knew each other at all.
Ryan:	Yeah, at the start there was a massive tension between like me, him, Jake and this other lad called Kieran and then we all became the best of friends.

The importance of making friends and being socially accepted was evident from their frequent exchanges in lessons that were not always focussed on functional mathematics. Lindsay was rarely daunted by their on-going social chatter and would often become involved before turning the students' attention back to mathematics. She was able to use these short interactions to build personal relationships rather than trying to quell student conversations in a more confrontational manner.

For this group their functional mathematics lessons in college were very different from learning mathematics in school. The focus group depicted their experiences of school mathematics in negative terms with examples such as their teacher never being at school, always having supply teachers and spending some lessons just talking about rugby with their teacher.

The students seemed concerned about their lack of learning in school and often attributed this to difficulties in getting enough help, as explained in the following extract.

Damien:	I used to have an extra other lesson but when I was in the proper lesson they used to teach and I used to put my hand up after he'd spoken to see if he could explain it again but then he wouldn't because he said "Well I can't because you've already listened to me once. You can get on with it" but I never used to be able to do it you see but I never used to get extra help and then I did a little bit but not as much as I did in college. That's why I've found it easier this year.
Lee:	You know when you asked the teacher for like help they said "Well you should have listened" and they won't tell you again.
Diane:	Why do you think that is?
Tammy:	They were never like that in my school. If you asked for help they'd give you help but there were … you'd have to ask for help about ten times. It was just awful.
Ryan:	But sometimes they won't talk to you, they'll shout at you.
Lee:	I used to get that a lot!
Jake:	Before Year 11 and the GCSEs I was like really bad at maths so they put me in the bottom set, like the bottom set where there was about 8 people in my set and they would just give us like work that was for Year 2's, like naming shapes and stuff. It was like "What's the point?" They'd kind of given up on us. It was like the group that aren't going to learn anything which is kind of annoying you know.

There was general dissatisfaction with their experience of education and a feeling that they were neglected or "outsiders" in the mathematics classroom. Despite their negative experiences in the past these students seemed keen to learn. For example, when asked what would be the most important things about a good maths lesson there was general agreement with the response given by Jake who explained "At the end of the day I've learned something."

Functional mathematics lessons in college were described as a positive experience through which they had learned more than in GCSE mathematics at school. They felt the work was not too difficult but did involve some new learning and this combination provided motivation. For these students the prospect of a second chance with mathematics was good as long as the learning seemed achievable but finding a balance between sufficient and insufficient challenge was important.

> Jake: I was like I couldn't do my work in secondary school at all. I just used to get stressed out and walk out but now it's completely different.
> Ryan: Yeah, in a good maths lesson the work wouldn't be ridiculously hard or ridiculously easy. Like if it's sort of challenging you get stressed if you don't finish it and you don't work it out but like if the teachers aren't being too strict and if you sit with the right people and you talk a little bit then you don't get stressed out then that would be a good maths lesson.

Success or failure with mathematics was a factor that seemed to have a strong impact on student emotions, as Ryan explained.

> I like it because … like I'm quite good at it, so I like it, but I used to like detest maths, you know, strongly. (Ryan, Public Services)

Many of the students in this group seemed to have experienced some significant attitude changes in college and talked about functional mathematics being more fun than school where the lessons were "boring" and "straightforward" so they were less inclined to listen. Variation in learning activities seemed to be important.

> Ryan: You know like a roller-coaster, you don't want to just go straight forwards do you? You want to have spins and stuff. This is...
> Lee: You want variation.
> Ryan: Loop the loop.
> Lee: Like Oblivion.

The students also frequently referred to changes in their relationships with teachers in college and how this affected both their attitudes and their learning.

Diane: So what makes it interesting and fun? Is it the stuff that you do or the way that you do it?

Darren: The way that we do it.

Ryan: It’s like the teacher’s attitude towards it.

Darren: The teacher’s more approachable.

Ryan: I think if we had a different teacher, one which kinda wasn’t too into it. Like I had a maths teacher in GCSE maths who just wasn’t interesting. It was this is it; this is how you do it. Where Lindsay like dissects it and kind of makes it…

Damien: She explains it more as well.

Ryan: Yeah the teacher makes a big difference on how we think about it.

There was an impact on learning due to the methods used but the teacher’s attitude was also important. Lindsay’s enjoyment of teaching was transparent and the students responded positively.

Ryan: Like we can be a loud class and she never really, she’s never actually split us up at all and that kind of you get more…

Darren: We’re more respectful towards people that…

Lee: Are nice to us and…

Ryan: Don’t overreact.

Lee: Yeah.

Lindsay was relaxed about students talking and, rather than discouraging discussion or irrelevant remarks, she used conversations to stimulate interest and build relationships, accepting that there would be some lost time as well as gains. This was perceived by students as an adult approach and earned Lindsay respect.

These students actually attributed much of their change in attitudes to Lindsay. The relationship they had developed was different from the way they related to their mathematics teachers at school and affected their engagement with lessons.

Darren: I don’t know. I just think like – it’s not really functional maths but I think we’d probably completely disagree with functional maths if we didn’t have the teacher we had.

Ryan: Yeah. Totally.

Jake: Yeah. It’s a lot about the teacher.

Darren: Plays a big part in it.

Ryan: Because you don’t want like miserable people like saying “Enjoy the ride!” You don’t want that you want like ”Enjoy your ride. I’ve been on this. I’ll recommend this” It’s good, yeah.

Jake: I remember in secondary school if I didn’t want to do maths I wouldn’t do it I’d just sit there but now I’ve got a teacher that kind of slightly motivates me so…

Ryan: You don’t want to let her down.

Darren: You want to finish the work sheet.

The roller-coaster analogy was used by students in their discussions in several ways but this description was consistent with the lessons that were observed. On occasions it appeared that the amount of learning taking place was small but then students suddenly began to answer questions and demonstrate their understanding of the topic. Meaningful discussions were sometimes disrupted by inappropriate remarks or diversions and progress with written work for some students seemed to take place in sudden bursts of activity rather than continuously. Despite this 'roller-coaster' impression of their experience, the enthusiasm for functional mathematics from the focus group increased through the year and they maintained their positive attitudes despite the setback of failing their first attempts at the examination in March.

4.1.3 The relevance of functional mathematics

In response to questions about why students come to college, the focus group suggested that it was usually about getting a job. Employment was the intended destination and finding a route towards that goal was becoming a priority.

> There's not that many jobs so you're going to have to come to college to get more education so you can get a better, higher job. Or they just won't take you on. (Damien, Public Services)

Some students had a definite career in mind but the transition to employment was incomplete and there was still some uncertainty about their choices.

Darren:	I'm not 100% sure but I think I want to go into the army.
Damien:	I did want to come to go into the Fire Service but now I want to go into the Police.
Lee:	I've always wanted to go into the Police.
Ryan:	Yeah, I was like, ever since I can remember I wanted to be in the Police but then as I grew up I was like … I kind of changed my mind…

Student discussions indicated that they viewed functional mathematics as a relevant part of their trajectory to these possible careers for various reasons. Some referred to needing the qualification to enter their chosen career or valuing the qualification as a useful addition to their CV. All these students, however, were required to pass functional mathematics if they wanted to progress to the next level of the Public Services programme in college and most were intending to follow this route.

These students valued the skills they learned in functional mathematics and discussed in the focus group how these were more useful than GCSE mathematics because the problems involved working out “everyday things.” It was the connection between functional mathematics and their personal lives that seemed to convince these students that the subject was relevant.

> Darren: It’s completely different because like, because we’re older it’s more adult. They used to do it with like jugs of water but now they’re doing it in like alcohol units and stuff that more relates to us now.
>
> Lee: It teaches us about like the stuff we do, it teaches about like what we will need in life like is actually good that we learn the stuff. I mean, units of alcohol we did the other day and we’re doing stuff on cigarette prices and like stuff that we’ll need.

The link to their lives was often through the context rather than the actual application of mathematics. These connections stimulated engagement with the lessons but the choice of context was crucial. Students were increasingly identifying themselves with an adult world and issues that related to their lives, such as smoking and drinking, captured their interest. They noticed how in functional mathematics lessons how they were being taught about lifestyle as well as mathematics and this was directly linked to Lindsay’s strategy of discussing the context and its implications for their lives rather than simply teaching the mathematics.

The students were able to give several other examples of interesting and relevant work they had done in functional mathematics classes that contrasted with their experiences in school.

> Ryan: We did one about McDonalds and Burger King, the calories and stuff and then the first lesson we did it was gardening and it was like how much soil we needed and how much concrete and how we could spread it out and stuff.
>
> Lee: And we did, like instead of school, the only thing which is like that in school was when we did ingredients for a cake and that was it and then we never learned anything else because it was like Jane pours two millilitres of water into a glass, like who’s just going to, you know, pour water into a glass or...
>
> Ryan: Like, I won’t ever use equations or anything. Like when am I ever going to do an equation in my life? But like with coordinates and stuff in functional maths it’s very easy. Like even in the army I would have to do that.

The transition towards employment was becoming an important part of the educational environment in which their learning of functional mathematics was taking place and their developing interest in a specific vocational area provided opportunities to relate mathematics to their personal goals or relevant issues.

These students were beginning to see a relevance for functional mathematics through the teaching that presented the subject as a useful ‘tool for life’ rather than academic knowledge. Ryan was keen to describe the moment of revelation when this suddenly made sense to him.

> Ryan: I was in the Co-op like 4 months ago and I, um, they had these bars of chocolate. There’s two. They get like a decent size bar for a pound and I like no, no they’re like £1.13 or something and they’re like 100 grams each but then there’s like a big bar which is the same price but it’s a big bar and it’ll be cheaper to get the two separate ones. You get more out of it and it’s cheaper than actually buying the one which is bigger.
>
> *Diane*: So you’re saying that doing functional maths helped you with that?
>
> Ryan: Yes, it’s like an example of functional maths. Like you work out practical things like you would actually use in life but you’re not going to use Pythagoras’ theorem in the Co-op are you?

Functional mathematics became more relevant when it related to current issues in student lives but there were other ways in which the functional mathematics classroom seemed better aligned to ‘real life’ than school lessons. The students used the example of calculators to illustrate their point.

> Jake: Like when we’ve done work like back in school we wasn’t allowed calculators and stuff but in functional maths we’re allowed calculators.
>
> Lee: It makes you feel more comfortable and secure when you’ve got a calculator every lesson. Like even if you don’t need it. Like it takes the pressure off when you’ve got like…
>
> Ryan: … like you’re trying to work something out but you’ve got to do like a quick division but you’re not too confident with division it’s like “Oh I’ve got a calculator, no problem” You don’t have to embarrass yourself or like get everything wrong.
>
> Lee: When I was at secondary school my teachers were like “When you’re at work you’re not going to have a calculator all the time” but in functional maths they’re like “To be honest you’re always going to have your phone on you and have a calculator”. It’s totally different.

One of the difficulties for students though was the relative value of the functional mathematics qualification compared to GCSE mathematics and there was clearly a tension between learning useful skills and having a qualification that was well recognised by employers. In her interview Lindsay expressed similar doubts about the value and recognition of the qualification, even though she too firmly believed that the skills were useful and relevant to students.

At the end of the year there was agreement that functional mathematics was “a good thing” but this was not the case at the beginning. The students admitted to being confused at first about why functional mathematics was relevant and only saw the connections later.

> Straight away I thought like “Oh, maths. I’m never going to need maths” and then like instantly my perspective on maths changed to functional maths. (Ryan, Public Services)

For some this change occurred quickly and this included those some students, like Ryan, who already had a GCSE grade C. Others gained confidence and became more positive about learning mathematics although their enjoyment of lessons did not always change their basic attitude to the subject.

Lee:	I found it easier. The things that we do in functional maths, they should put it in the GCSEs at secondary school so it’s easier for them.
Jake:	Well I’m a lot more comfortable with it but I still hate it.
Ryan:	On the odd occasion, say if you had to go to the supermarket or something, like and you’re trying to work something out and you’re not too comfortable about doing it like when other people are around. Because I know people like that, quite shy, but like once I did this it was like I don’t care. I can just do it now so yeah.
Damien:	Oh yeah I’m a lot more confident now than I was at the start.

Their experience of learning functional mathematics was likened to a revision of material they had already met before but the different approaches used by Lindsay seemed to bring not only more confidence about using mathematics but also greater enjoyment.

Ryan:	Also it’s like because we didn’t do maths, we stopped for a little bit and then we started up again it’s like on a roller coaster it’s like it’s gone rusty so Lindsay’s put some WD40 on it.
Darren:	Yeah, cleaned it up.
Ryan:	…and made it attractive.

4.2 Case Studies of Functional Mathematics Groups: Public Services with David

This case study provides a contrast to the previous group since the attitudes of these students towards their experience of functional mathematics in college were negative. For the majority of the focus group, this represented a continuation of an existing disaffection that first developed in school. The students were taking a Level 2 Public Services course with a view to a career in the either the police, fire or emergency care services, although a small minority were considering the armed forces.

4.2.1 Introduction to the student group and their teacher

David, the functional mathematics teacher, had only been teaching in Further Education for a year. He was a smart young man who was working hard to be a professional but was encountering some challenges in the unfamiliar world of Further Education. His position was temporary and not linked to any particular vocational area, although the majority of his sessions fell within one section of the college. In this respect his role was similar to that of a member of a central team servicing several departments. Over the course of the year there were frequent changes to student timetables for this group, partially caused by staff absence but also reflecting what seemed to be a characteristic of Public Services courses in the study. The vocational programme varied from week to week, sometimes at short notice, and activities often took place out of college or on a different site.

The first lesson I was able to observe took place in an annexe that was set apart from the main building and was not normally used by Public Services students. Space was tight in the room and, although the students could all be seated at tables in rows, there was little room for the teacher to move between them. The size of the room clearly had an impact on the lessons since it was difficult for the teacher to check work, give feedback and support students individually. David later explained that the lessons had originally been timetabled in a room half the size and that he had found this vacant room himself because no-one else seemed able to find a solution. Rooming functional mathematics sessions suitably did not seem to be a priority.

An additional support tutor, Russ, was also present in the class. His role was to support two particular students in the group who had specific learning difficulties. The lesson was noisy and at times it was difficult to see what learning was taking place. After an introduction and some examples from David the main activity was to complete a series of worksheets individually about areas and perimeters. The students attempted some of the written work during the rest of the lesson although reluctantly. Several students seemed intent on avoiding work altogether and it was difficult in the crowded class to keep a check on their progress. A small group of students arrived very late, squeezed themselves into the remaining space and were given the worksheets.

The back row was obviously the place to be in this class and the students (all male) who occupied this position enjoyed varied conversations, in sometimes colourful language, about anything but mathematics. Despite being in close proximity they still felt the need to shout to each other and attract the attention of others in the class. It was easy for students to get distracted. Sian particularly enjoyed turning round to chat loudly with the back row. The 'back row boys' were obviously more attractive than functional mathematics.

David tried to circulate round the class to work with individual students and encourage them to participate but his methods had only temporary effects. It was difficult to get students to engage with the written work and frequent reminders were needed to keep them focussed. After a whole hour one student, Simon, in the far corner of the back row, had managed to avoid doing any written work at all. His blank worksheets lay on the table in front of him whilst he chatted to his friends but he skilfully gave the appearance of working whenever David turned in his direction. Several others seemed more interested in drawing on each other's arms rather than writing on their worksheets. Students' reactions to the lesson appeared to be particularly negative but the focus group, which included Sian and Simon, later provided an opportunity to gain some insight into the reasons behind their behaviour.

The personal tutor took responsibility for selecting the focus group, choosing three male and three female students to represent the class. The group proved to be very talkative and clearly comfortable presenting their opinions, even when these represented opposing views. From the first focus group meeting onwards they conversed readily but comments such as "Well Geoff [*the personal tutor*] did choose the worst people!" indicated a concern that their lively discussion might be a problem. On the contrary, the talkative and open group were a good source of data because they expressed their personal opinions without reservations.

In the first focus group meeting the students asked if they were the "worst group" in the research, which seemed to indicate that they themselves felt their behaviour in class was not exemplary. The sense in which this group typified an extreme position became clearer through subsequent observations and discussions but their general classroom behaviour and lack of learning were characteristics that quickly became apparent. In the following subsections the case study will be explored using two particular themes that emerged from their discussions.

4.2.2 Rules and relationships

In the first focus group meeting the students explained the differences they perceived between school and college. The following extract illustrates the opinions expressed.

Sian:	The difference in school and college that I noticed is that in school you get forced to do the work. In college … like I used to always argue with the teachers, but in college if you don't want to do it it's your fault.
Aaron:	You just get ... kicked off.

The students agreed that there was more freedom in college but this was coupled with a greater personal responsibility. In their transition to adult life they welcomed the opportunity to make more of their own decisions but realised college was not without rules and commented on how their personal tutor contacted them personally by phone if they were late or absent.

The students were aware of certain expectations regarding their conduct but there were indications that they were still testing out the boundaries and discovering the rules of their new environment. This on-going negotiation of their position in a new social group provided some explanation of their behaviour in functional mathematics. The calls for attention from the back row suggested that their social position in the group was important and transcended the need to engage with mathematics.

In my observation of these students in a vocational lesson the group dynamics and behaviour were very different. The session was a practical personal fitness class and here the 'back row boys' were keen to demonstrate their ability. Fitness was valued in Public Services due to the physical demands of careers in this area and the identity of these students was secure because they were able to excel with the physical exercises. In functional mathematics classes their position was less certain. Being seen as an expert in mathematics appeared to be socially undesirable in this group so other negotiations were taking place in order to establish their individual positions in the social structure of the functional mathematics classroom.

Their discussions in the focus group revealed more about the reasons for this insecurity with respect to mathematics. Most of the students described their experience of school mathematics in negative terms and there appeared to be several causes. The students referred to GCSEs as “hard” or even “horrible” and agreed that college work was easier. They talked about varied experiences with mathematics teachers in school that revealed how they had failed to connect with the subject or the staff. There was an underlying attitude of feeling neglected and a hint of helplessness that they attributed to the social conditions or actions of their peers.

Aaron:	At our school you had projectors and he put his laptop on and he was just watching baseball when we were supposed to be doing GCSEs.
Sian:	Only thugs go there. I got distracted.

They were familiar with classrooms where engaging with learning was not an accepted characteristic of the dominant culture.

Simon:	I hated my maths teacher.
Sian:	That’s not very nice is it?
Tina:	Hate is a very strong word.
Simon:	He was the head of maths. Yeah. He knew what he was on about. You just didn’t listen.

These students seemed to have conformed to the norms of their school classrooms but still preserved some desire to learn. In the transition from school to college there seemed to be an opportunity to break free from these norms and yet the same characteristics were present in the functional mathematics sessions observed.

The students agreed that they were happy in college and enjoyed their vocational course so the reason for their behaviour in mathematics was not due to any dissatisfaction with their general experience. There were, however, frequent comments from the students about being distracted in mathematics lessons rather than consciously deciding not to engage with learning, as shown by this brief exchange in the focus group.

Sian:	Do you know what? The littlest thing used to distract me in school. Half my work was…
Aaron:	What’s changed?

Getting interested and engaged in learning mathematics was a barrier that they seemed to find difficult to overcome. David worked hard to keep distractions under control by reminding students to be quiet and to get on with their work. He was concerned that the students were not learning but attributed this in his interview to their own lack of self-discipline. His response was to try and impose discipline on the students and "getting on with the work" seemed to become the dominant value in his lessons. His verbal reminders, intended to keep them working, were calm and persuasive but the strategy was ineffective. David's expectations were that once he had explained the topic then the students would learn best by working quietly and independently but they did not share his views and suggested a different approach.

> Sian: Yes but work in groups without him telling us off.
> Simon: Yes, so basically work in groups legally in class.

David's model of classroom learning appeared to be based on a view of effective teaching that was incompatible with the students' views of how they learned best. His concept of learning mathematics depended on an organised, orderly classroom with clear rules that he, by virtue of his position as a teacher, would enforce. David's temporary position and lack of experience meant he was vulnerable to challenges from students and he expected the college systems to provide the support he required. Rather than reinforcing his ideas of classroom control by teacher-enforced rules the college approach was different and difficult for him to grasp. He referred to the lack of sanctions available and new college guidance that took a lenient approach to student punctuality. These undermined his system of rules and discipline and weakened his authority in the role he had adopted.

David's reliance on rules and assumptions about his role set him apart from the dominant culture experienced by the students in college. In my observation of the personal fitness session it became clearer how the vocational tutor took a very different position. Geoff, who had been in the army prior to teaching, demonstrated each new move expertly before giving individual guidance and encouragement. The students respected him for his extensive military experience, aspired to his level of fitness and became similar to apprentices learning from an expert who was demonstrating and coaching rather than instructing. David could never be in the same role since he represented a mathematics expert and none of the students were intending to be mathematicians or mathematics teachers. Respect had to be earned another way.

In addition to these differences, inconsistencies in David's implementation of the rules also affected student attitudes. On one occasion Sian chatted to friends and avoided doing any mathematics for a whole lesson. Later, in the focus group, she commented on David's response.

> But the thing is as well you don't have to do it. I've been in a couple of lessons where I've done no work and he says "Oh you can go" and you've done no work. I've just had a paper in front of me. That's it.
>
> (Sian, Public Services)

David noticed the students that worked well and began to reward them by letting them go early whilst the others had to stay. This idea of 'reward' and 'punishment' where the teacher alone had the power to make the judgments contributed to a relationship that belonged in a formal classroom more than a vocational training course. Furthermore, the inconsistencies in David's judgments contributed to student perceptions that the lessons had little value. David referred to Sian as one of the most disruptive students yet sometimes allowed her to leave early with those who had finished their work, even though she herself had completed nothing. It did not go unnoticed by other students who questioned the justice of these decisions.

Similarly, when students were informed which level of examination they were going to take, Simon, who already had a grade C at GCSE and seemed capable of Level 2 was only entered for the Entry 3 test. Tina, who also had a grade C at GCSE but worked quietly through the lessons, was entered for Level 2. These unexplained decisions did not earn David respect.

A further difficulty for David in establishing his position with the class arose from the actions of the support tutor (i.e. teaching assistant) who attended every session. Russ was officially designated to support two particular students but took a much more prominent role in the sessions. He often introduced a starter activity or a five minute mid-session activity to provide a break from individual work. His contributions to the lesson were intended to help David but led to some confusion about who was really in charge.

Sian:	Oh yes. Because we have a main teacher and the other one always butts in so he's telling us one thing. Like the other day he was explaining one thing and David went to explain another thing and then as soon as you get the hang of the work you swop.
Simon:	In David's lesson Russ always takes it over.
Tina:	Yeah, I know.
Sian:	I don't get that.
Aaron:	Russ is the better teacher I think.
Simon:	Yeah, I think he's being watched for the rest of the year.
Sian:	Who, David?
Aaron:	Yeah.
Simon:	To see whether he can teach or not.

This lack of confidence in David seemed to mainly arise because of differences between students' expectations of him as a teacher and his actions. His approach to teaching was based on assumptions and values that were also inconsistent with those of the students. For example, freedom and personal responsibility were aspects of college culture that they valued but David's system of rules did not accommodate these. The absence of shared values created a classroom culture characterised by tensions. Students were uncertain of their identity and unclear about the rules of the classroom community. They reverted to behaviour associated with their experience of similar situations at school and made personal choices about whether to engage with functional mathematics that largely reflected established attitudes.

The reasons why some students chose to participate, albeit reluctantly, whilst others made little effort were difficult to discern. Simon found it hard to explain why he deliberately avoided doing any written work one week but completed several worksheets in the following lesson. "I was just in the right mood this week" was his conclusion. Students' attitudes and emotions were influential in their decisions regarding participation but David seemed to believe that they should engage with mathematics simply because it was an important subject. The value of understanding students' attitudes and incorporating strategies to change them was something he had not grasped.

Students' existing attitudes towards mathematics and their emotional responses were significant factors that had an impact on their learning yet these remained largely unaddressed in David's approach. They suggested that lessons should be more fun, more practical and interactive rather than focussed on working individually. David's emphasis on individual written work did not match their preferences and simply reinforced existing negative attitudes.

Sian:	It's not like we even get taught is it?
Aaron, Tina:	No (together)
Sian:	We get a paper and we have to do it. That's it. Done.
Aaron:	No, we don't do like a subject it's just a paper every lesson and you just pass it and he gives you another paper and you do that and you do another paper and then you go home.
Tina:	You do like 5 or 6 sheets of paper and then you go home.
Aaron:	And he says take it home with you and no-one's going to store it. You just chuck it in the bin.
Sian:	You know I took some out of my bag this morning from November time. I didn't do it and it was still there. He didn't ask for it back or nothing. So, personally I don't think there's any point in me doing it because he says yep, yep, yep, done. That's it. Instead of saying you could have done this this way, there's other ways of doing it and working it out.

There was an underlying concern that they were not learning, which David himself seemed to share, but their views on how to achieve an effective learning environment differed greatly from the strategies that David was implementing.

4.2.3 The relevance of functional mathematics

The students in this group all needed to pass a functional mathematics qualification in order to progress to the next level of their vocational course so there was an obvious 'exchange value' for the qualification and a reason to succeed with their functional mathematics course, although this seemed to provide little actual motivation.

Aaron:	It's just a qualification to get us into next year isn't it?
Sian:	Mm.
Aaron:	Doesn't mean anything actually because…
Tina:	Not if you've already got it.
Sian:	That's the only reason why people take it isn't it?
Aaron:	Exactly. It's just a thing to get on to another course.
Sian:	No one would…if you had the choice to do it or not no-one would ever do it.

Some students felt the qualification was just an addition to their CV that might help them get a job although it was unclear whether they really thought it had any real value for their lives.

Aaron:	You don't need maths in the future. Let's be honest about it.
Sian:	You don't really need maths to get a job.
Tina:	You do really.
Sian:	I just think the only reason you need the qualification is to just to make your CV look pretty. Because that is the main thing isn't it?
Aaron:	No, because people are bothered about GCSEs aren't they? Not about functional skills.

From their perspective the value of a functional mathematics qualification was less than a GCSE and this made it irrelevant for those who already had a grade C at GCSE. This judgement reflected their perception of functional mathematics in college, which they described as involving only basic mathematics and being easier than GCSE since some of the difficult topics were excluded. There was a contradiction, however, between student statements about basic calculations being the only mathematics they would ever use in real life and comments about functional mathematics having no relevance.

Sian:	You never use it in real life. Obviously it helps you, say like you worked in a shop it helps you then. Or if you're doing millimetres

	and centimetres when you're measuring stuff, like milk or whatever for your kids.
Tina:	It does then.
Sian:	You use it then but algebra and all stuff like that, I don't see how you would use that.
Aaron:	You only need the basics really.

There were also tensions between the perceived usefulness of basic mathematics and an association of this level of content with their earlier years in school. This led to assumptions that functional mathematics was "childish" and beneath them. Aaron likened functional mathematics to work he had done in Year 9 and one particular task to primary school mathematics.

> So these questions for like a 17 year old are stupid. I mean, you do this … like my nephew probably does this and he's eight. Do you know what I mean? It's pointless. (Aaron, Public Services)

The problem-solving skills required for functional mathematics were not recognised as a part of the subject by these students. Lessons were associated with basic content knowledge and the absence of meaningful contexts for tasks only added to their impression that this was childish mathematics in a setting reminiscent of school.

The place of mathematics in their adult lives was still an uncertainty and they had difficulty understanding the relevance. This was a theme to which they returned on several occasions in the focus groups and some lively discussions took place. The following discussion illustrates how the girls in the group tended to take the position of advocates for mathematics as a useful 'tool for life' whilst the 'back row' boys tried to deny the need for mathematics by ridiculing their suggestions.

Diane:	What do you want to do?
Tina:	Paramedic.
Diane:	Do you need maths for that?
Tina, Sian:	Yeah (together)
Simon:	Why?
Sian:	Cos you have to …
Simon:	Count up how many dead bodies there are?!
(Laughter)	
Simon:	One, two, divide by two!
(Laughter)	
Sian:	Because you need to know like measurements of what your medication is and stuff.
Tina:	Yeah.
Simon:	Come on.
Aaron:	You take the temperature.
Simon:	I've got the whole group on me now!

Sian:	Take your pulse!
Tina:	When you're giving morphine or something like that.
Sian:	When you're giving medication.
Simon:	Gulp. Medication!

In another discussion some students expressed their belief that the qualification might help them get a job but that they didn't actually expect to use any mathematics once employed.

Tina:	Yeah. I'll use it.
Aaron:	To get a job but not to actually use it.
Sian:	Yeah. What do you want to do? What do you want to do?
Aaron:	Be a mathematician!
(Laughter).	
Sian:	No, seriously, what do you want to do?
Aaron:	Fire Service.
Tina:	Well, you need maths to go in the Fire Service.
Sian:	You need to calculate…
Aaron:	You mean when the building's on fire you calculate how high it is before you jump out?
Sian:	Yeah.
Aaron:	For God's sake!

David stated that he believed mathematics was important to students' future lives and tried to use 'real life' contexts and situations for mathematics that might interest the students but they failed to see the connections. For example, during one lesson he introduced a task about carpeting a flat which, as he later explained, was chosen because he believed several students were thinking about getting a flat of their own and the task would generate some interest. This was a reasonable assumption and consistent with contexts that the students themselves suggested in the focus group. David's worksheet, however, gave the impression of being unconnected to real life because of out-dated prices and a simplified floor plan that omitted realistic details such as the position of doors and windows. Furthermore, when introducing the task, David focussed his attention on getting students to understand what calculations they needed to perform rather than discussing the context and establishing connections to their lives. The opportunity to make this a meaningful and relevant task was missed and the students failed to see the relevance.

In the second focus group meeting the students discussed three unfamiliar contextualised tasks as listed in see Appendix 1.8 (page 276). The first task, about buying an MP3 player, (page 279) was rejected as irrelevant on the grounds that they would never buy one because they used their phones instead. They believed that if they were comparing similar devices then only the price and capacity were of interest, not the additional features listed in the question (e.g. size, weight). Aaron also expressed strong views that this was a "pointless" task because it was not mathematics, just a comparison of information with no real calculations.

A second task, around alcohol awareness, (page 280) was judged as the most relevant and interesting because of the connections to their current lives.

Tina:	I don't know one teenager that doesn't drink.
Aaron:	Yeah, it relates to your life because everyone does it.

They referred to drinking as an essential part of teenage life but also agreed that some awareness of the effects might be relevant if they joined the police. The actual mathematics in this task was only loosely related to the context but none of the students commented on this aspect of authenticity (i.e. would you ever need to do that calculation in the situation). The scenario was only a superficial cover for some unrelated mathematics but this did not seem to be a concern. For these students establishing a connection to their lives was important but seeing a link between the context and the mathematics involved was not.

The examples given by students of relevant and interesting contexts (e.g. rent, bills, alcohol) represented elements of adult life and illustrated how the transition from child to adult was becoming a dominant factor in their thinking. Their experience though was still limited and they often needed help to make the connections between mathematics and their future lives, although contexts that related to current experiences were more readily recognised (e.g. alcohol). This need to help students construct these connections was something David did not seem to appreciate and therefore it was not addressed in his lessons.

Students were also unclear about the links between functional mathematics and their vocational course or future career, as the following extract from a discussion about a measuring task illustrates.

Diane:	What about your Public Services course? Is there anything in here that would help you or relate to your Public Services course?
Aaron:	Probably converting millimetres to centimetres… except I can't think when you would need to use that but …
Sian:	Probably distance and time.
Tina:	Yeah.
Sian:	Probably because you go orienteering and stuff like that. I don't see how millimetres and centimetres would.
Diane:	Do you use millimetres and centimetres at all on part of your Public Services course?
Aaron:	No.
Sian:	Not really.

Tina:	It's like in the Police Force and stuff you use like speed and miles and stuff like that. So if you're car-chasing they would be so many miles in front like or if there's a 5 foot drop or something like that.
Diane:	Do you ever use scale on your Public Services course?
Sian:	Only in orienteering.
Aaron:	Right.
Sian:	Because you're drawing to scale of where you've got to go and what path to take and all stuff like that.
Tina:	I didn't do very much last time. We got lost.

Expeditions and orienteering were part of the Public Services course and therefore map scales and measurements were important but the students struggled to see the connection. In their functional mathematics lessons the vocational context was rarely used and the students struggled in discussions to provide examples of how mathematics may be used in the workplace. In contrast, their vocational tutor, Geoff, identified a wide range of applications of mathematics from his military experience that the students might need to use in the future. There was evidence of communication between David and the personal tutor about practical matters, such as timetabling of lessons, but there appeared to be far less discussion about these uses of functional mathematics in the vocational area and opportunities for meaningful connections were being lost.

For this group of students the disconnection from mathematics and a disaffection that had originated in school remained throughout the college year. Opinions on whether the functional mathematics course was worthwhile varied in the first term but negative attitudes prevailed in the final focus group. Tina (who had a GCSE grade C) achieved a Level 2 pass in functional mathematics but she concluded "I hated it then and I hate it more now!" She saw no point in having two qualifications in the same subject even though she suggested that functional mathematics was perhaps "a different way of seeing things". Sian (who had a GCSE grade E) failed her Level 1 examination and eventually decided that school mathematics had been better anyway, although she found it hard to explain why when questioned on this.

Diane:	So you had a better experience in school?
Sian:	Mm. Though I got kicked out of nearly every class.

Aaron (who had a GCSE grade E) passed Level 1 but felt it had just been a refresher of basic mathematics and pointless for anyone who already had a grade C. Simon, who already had a GCSE grade C, was only entered for Entry Level 3 and failed to understand why.

4.3 Case Studies of Functional Mathematics Groups: Hairdressing with Richard

This case study concerns a group of students who were taking a Level 2 Hairdressing course. Some of the students had progressed from a Level 1 Hairdressing course in the previous year whilst others were new entrants to the college. The group was entirely female but included several mature students, two of whom were second language speakers. Their responses to functional mathematics were mixed, despite having the same teacher, but this was representative of the range of views present in several of the case study groups. This case provides an opportunity for insight into features of lessons that prompted different reactions from individual students within a single group.

4.3.1 Introduction to the student group and their teacher

Richard was fairly new to teaching but was confident and enthusiastic due to some early success with groups in the previous year. He had a history of employment in the armed forces before working for a small business and then becoming a teacher. His experience of mathematics was of a subject he liked and used in employment rather than one that he pursued to a high academic level. Despite his experience in the army, Richard's teaching preference was for functional mathematics rather than the Public Services courses that were more closely related to his background. After completing his teacher training he filled a vacancy in the Hair and Beauty department for a functional mathematics tutor. As a member of the vocational department with an entire timetable of teaching functional mathematics to Hair and Beauty students he had quickly become familiar with the area. Although he remarked on the fact that he was the only male teacher in a female environment this did not seem to be a problem and he was clearly accepted as one of the team.

The first lesson observation was scheduled for the end of October. It took several minutes to walk across the site to the timetabled room from the college block where the students had their hairdressing sessions. This was something later raised as an issue by the group who questioned why they could not be taught in a room nearer to their vocational base. Although the teaching room was pleasant and had ample space, the posters on the walls indicated that this was a mathematics room used primarily for A-level teaching. Both these aspects of the learning situation seemed to subtly reinforce the perception that mathematics was remote and unconnected to the students' vocational course.

Whilst waiting for other students to arrive Richard chatted in a relaxed manner with those present about life outside college. He seemed comfortable conversing informally on a personal level, listening to students and sharing his opinions in the discussion. There was an overall impression that relationships of informality, trust and respect were already well established and attitudes towards Richard appeared to be positive.

The other students arrived in small groups at intervals and arranged themselves around the room in distinct clusters. Although there was some communication between these groups the clusters tended to work separately and exhibit quite different behaviours. Zara's group were loud and their concentration was variable. Ellie's group worked quietly and steadily with support from Richard when required. The two second language speakers needed extra help to understand the questions but worked with determination once they had grasped the meaning. Teresa, a mature student often asked for help, quickly became impatient and frequently turned to her closest neighbours for explanations. The loudness of Zara's group often dominated the lesson and this seemed to irritate Teresa. This social fragmentation of the class into separate units and the suggestions of tensions between the sub-groups became more visible later in the year as the divisions deepened and hidden emotions surfaced.

The lesson began officially when Richard closed the door and introduced the task for the day. Without a clear statement of the aims or objectives the students were provided with a task about making an appointment schedule. This commenced with a short revision of facts about time. Recalling the number of days in a year caused some difficulty and a couple of students were concerned when they had to use the same number twice (60) as the answer to two questions. Despite the fact that most of this revision was safely within their existing knowledge base their confidence was easily challenged by anything unexpected or non-routine.

The remainder of the task involved making an appointment schedule for a hair salon using a list of phone messages that were not uniformly recorded. In this way the information had been made to appear 'realistic' although the details had been neatly typed up. Students were expected to produce individual solutions although discussion was allowed. The task was fairly unstructured and open-ended since there were multiple ways of tackling the task, a range of possible solutions and a free choice about how the schedules were recorded. To produce a solution the students had to draw on their own vocational knowledge about hairdressing because the length of time required for each treatment was not provided. This use of scenarios that related to hairdressing, making links to the vocational course and placing an emphasis on open-ended tasks, proved to be common features of Richard's lessons that reflected the views he expressed in his interview about teaching functional mathematics.

There were two aspects of this first lesson that were indicative of specific influences in this group that affected student learning. Firstly the social fragmentation into sub-groups seemed to have an impact on the classroom environment that was not easy to handle. Secondly, Richard's attempts to link functional mathematics to real life and make students think through practical problems with a "common sense" approach met with different reactions from students. These two aspects are explored in more detail in the following sections.

4.3.2 The social environment and the impact on learning

In the first focus group there was discussion about the main reasons students had come to college. They agreed that working towards a career was an important factor and all expressed some interest in hairdressing. Rhiannon's suggestions that students come to college "Because we don't want to be on the dole" and that hairdressing was just "easy money" indicated that there may be other priorities as well that affected some students' decisions. One of the vocational tutors later explained in her interview that not all the students on hairdressing courses were actually interested in hairdressing. Students at Level 1 and 2 often transferred between different vocational routes due to changing interests or left college for employment, if the opportunity arose, since earning money was a more attractive short-term option. In their transition to adult life and employment it appeared that the desire for financial independence was a major influence and that interest in their chosen subject was not necessarily their main motivation for pursuing vocational training.

The students also described their experiences of school in the first focus group. Their feelings were generally negative and comments such as "I hated school, absolutely hated it", having "really bad attendance" and "I used to run to get out of things" were used to describe their reactions. They talked of liking college much more than school and the transition from a school environment to college brought some welcome changes.

Diane: So what's different about college then? What are the best things about college?

Rhiannon:	You can go for a fag whenever you want. Because you can't go for a fag at school can you?

(later in the discussion)

Ellie:	You know what I actually enjoy coming to college. I actually really enjoy it.
Rhiannon:	It's better than …
Leanne:	It's probably the days. You don't have to spend every day of the week do you?
Ellie:	It's a thing that I want to do. In school it's not a thing you want to do is it?
Keira:	Yeah, I hated school.
Rhiannon:	But here we have actually chose summat what we want to do, that we're interested in, so I think that's probably the best thing about it.

The transition brought a type of freedom that they appreciated and it appeared to represent a step towards the independence associated with becoming an adult. Having the opportunity to make a choice about their educational pathway seemed to provide a motivation that was lacking in their attitude towards compulsory education in school.

The social aspect of college was also important for these students. They felt college was a place to "meet boys" and "meet your friends" but when questioned further about the importance of friendships there was a hint of the friction in the group.

Diane:	How important is it having friends at college?
Leanne:	Very.
Rhiannon:	Very if you're like Mia.
Leanne:	Don't be nasty.
Rhiannon:	I'm only joking.
Ellie:	Yeah, you need friends.

Mia, a quieter member of the class was associated with a different social group from Zara. Despite the suggestion that this particular remark was just a joke, other comments in focus groups indicated that social tensions were affecting the class. In their discussions remarks such as "You was in the dumbest class!" and "Do you really not know your times tables: two, three, fours?" had the potential to undermine the confidence of these individuals and produce uncomfortable emotional reactions.

One of the strongest characters in the tensions between sub-groups was a mature student, Teresa, who viewed some of the younger members of the class as immature. Teresa herself had several children and some work experience but she was struggling with functional mathematics and often became frustrated with her difficulties. For her it was embarrassing to have her lack of understanding exposed in class and to feel inferior to the younger students. Her emotional sensitivity to the challenge of functional mathematics did not sit well alongside the teasing that took place between some of the others. Teresa gathered a small group of friends closely around her and kept a distance away from the 'banter' but this only deepened the divisions between her and Zara's social group. This was a difficult situation to handle for Richard who was aware of the tensions and commented on the problem in his interview. The presence of mature students in a group had, in his previous experience, been a positive influence since the older students had been more aware of mathematics in their lives, quicker at grasping the applications and willing to support younger students. In this case, Teresa's mathematical struggles and strong opinions were a problem that had negative consequences for others.

Social aspects of college life were important but students did not only refer to interactions with their peers. Relationships with teachers had played a significant part in the past and were still important.

> You know when you used to like 'shout out' in school he used to flip didn't he? He used to give detentions. (Rhiannon, Hairdressing)

In contrast Rhiannon found Richard more relaxed and even suggested that he "just lets you do what you want." Lesson observations would suggest that he was actually gently guiding students and facilitating learning rather than taking a more confrontational approach but this represented a sharp contrast for Rhiannon and a rather different relationship from those she had experienced previously with teachers in school.

Students' opinions about Richard and his lessons fell into two clear categories. In the first focus group the difference in initial responses became apparent when the students were asked what their functional mathematics sessions were like.

Leanne:	I think Richard makes it more interesting.
Ellie:	Yeah, he's probably the best teacher.
Leanne:	At school they used to make us sit in silence.
Ellie:	Yeah, I hated my maths teachers at school.
Rhiannon:	I think all of you lot agree that you like maths here apart from me.

Rhiannon explained that she found the lessons "Boring" but others felt it depended on what they actually did. These differences became clearer later in the year when, for practical reasons, the same students took part in two separate discussions. Firstly there were students who appreciated Richard's relaxed manner, seeing him as supportive and motivating.

Leanne:	I think that's why we wanted to learn… for Richard, yeah.
Ellie:	He helped us like – he's the sort of teacher like that's not strict like he's – he is strict but he's not strict like do this, do this, do this. He can have a laugh and a joke with you and then he's like 'right now come on you've got to learn, you've got to do this' which I think having a nice teacher makes you want to learn more than having a horrible teacher.

For Ellie and Leanne their relationship with Richard had more equality and informality than their teacher-pupil relationships in school and this reflected the values of a college ethos in which students were viewed as adults. Richard was instrumental in their learning process not only as a mathematics teacher but as a person who had considerable influence over their attitudes and engagement with the subject.

They later explained further about their attitude changes during the year and how this had led to better achievement.

Ellie:	I thought I was a lot cleverer than what I am.
Leanne:	Yeah I did.
Ellie:	But when I actually like learned more into it I knew that … now I know that I wasn't as good as I thought I was … that sounds stupid now but that's how I thought.

Having started from a position of confidence, the revelation that they were not as capable as they thought eventually produced better outcomes in terms of understanding. Richard's emphasis on practical problem-solving and his strategy of using open-ended tasks as a means of promoting deeper thinking were a challenge but had positive results over the year as this extract from their final focus group discussion indicates:

Diane:	In what way have you got better then?
Ellie:	I understand things more better now. Everything seems a lot more clearer.
Leanne:	I don't get stuck on anything.
Ellie:	Yeah, I can just get through a worksheet without being told anything.

In contrast, a separate discussion towards the end of the year showed that Rhiannon and Keira had very different opinions about the course.

Diane:	So can you go back to the beginning and think about how you felt when you came at the beginning of this year and how you felt about maths.
Keira:	Uh!
Rhiannon:	I hated it and we're still doing it.

During the course some students, like Rhiannon, maintained negative attitudes to functional mathematics but others seemed to overcome their initial reactions. One of the critical factors for Keira and Zara seemed to be whether Richard let them take a higher level or not in the examination.

> Zara: In his defence the teacher's not bad. He's letting me have a go at Level 2 this year.
> Keira: But he won't let me have a go.

These decisions on their level of examination entry were typical of single incidents in other groups that sometimes had a strong influence on student opinions. Some students seemed particularly affected by isolated events, suggesting that self-confidence was fragile and easily damaged. Despite some outward appearances of self-confidence from individuals such as Zara, Teresa and Rhiannon, many of the students in this group seemed sensitive to small incidents and vulnerable to the effects of the social tensions. Although Ellie and Leanne established a relationship with Richard that had a positive influence on their attitudes and achievement, Rhiannon and Zara were less certain of their acceptance and retained their dislike of mathematics.

Other adjustments needed in their new college environment were also challenging. One of the vocational tutors explained in her interview how new students were often scared by the responsibilities of working in a training salon with real clients. She believed they retreated into small social groups for security and this seemed consistent with the situation in this group. Vocationally-based challenges to confidence and social adjustments to a new situation were also accompanied by low levels of self-efficacy with respect to mathematics and therefore in functional mathematics sessions emotions were particularly sensitive.

At the end of the year Ellie and Leanne explained that they had actually enjoyed the functional mathematics course and believed this was due to an improved understanding of mathematics. Ellie tried to explain the interaction between success and enjoyment as follows:

> I say maths is like fun if you like … I think maths can be fun if you could know what to do. Like if you know how to do it, how to solve problems, it could be fun but it's just the fact of learning it and getting a grasp of knowing how to do things and working out different ways to get the right answer. (Ellie, Hairdressing)

Ellie described her feelings at the beginning of the course with the phrase "Scared. I hated it", but later expressed her elation when she passed the examination.

Diane: So when you got your pass how did you feel about it?
Ellie: Happy. I got a text and I ran round the back of my work. I was dancing.
Diane: So you were very happy about it?
Ellie: I was well excited because I didn't think I'd be able to pass it because I thought I was stupid. I didn't think I'd pass it.

Increased understanding led to more positive emotions for Ellie, which in turn resulted in better motivation and examination success. The change in her emotional response to mathematics, from hate to enjoyment, was clearly entwined with her gains in understanding and achievement.

Ellie and Leanne had distanced themselves from the other sub-groups and their positive relationship with Richard became the main influence over their learning experience. In contrast, Teresa turned to others in the class for support but her insecurity remained and her frustration with functional mathematics began to influence others. Zara and Rhiannon had spent little time in school and were still uncertain of their relationship with education but did achieve some success with functional mathematics. The presence of social tensions between small sub-groups had little effect on Ellie and Leanne but the emotional vulnerabilities of Teresa, Zara and Rhiannon mean that their learning experience was influenced by daily changes and critical incidents in their relationships.

4.3.3 The relevance of functional mathematics

In the first focus group meeting the students made several comments about the differences between the GCSE curriculum and functional mathematics. Some of them identified a demand for reasoning and problem-solving in functional mathematics rather than performing routine calculations, as this extract suggests.

Diane: And is it similar maths to the maths you did at school or is it different then?
Ellie: No. It's a lot different. It's like you've got to think about the question and think of the right answer rather instead of like just solving the problem you've got to think into it.

In the observed lessons there was an emphasis on using open-ended, multi-step problems and these presented a challenge to students who were used to a more structured approach. Richard explained in his interview that he wanted them to become familiar with more realistic applications of mathematics rather than textbook questions and to merge mathematics with the 'common sense' they would need to use in the outside world. The range of responses from students to such problems was illustrated by their attempts at a task in the first observed lesson which involved planning an appointment schedule for a hair salon using records of telephone requests from clients. Richard had included some ‘errors’ in the information to make it more ‘realistic’ and to prompt some ‘common sense’ thinking. Faced with a request for an appointment at 11pm the students made some interesting assumptions.

One student adopted the ‘common sense’ approach by assuming it was wrong and, when prompted, suggested that in a real life situation she would contact the customer to check. Some students simply ignored the request because they were uncertain about what to do. Their lack of confidence resulted in leaving aside anything that presented a challenge. Another student produced a schedule that kept the salon open until midnight. When questioned she explained that if it were her business then she would stay open whenever the customer wanted to come to avoid losing money. Her plan included closing the salon the following morning on the assumption that you always have a morning off after a late shift but she failed to realise that this was a Saturday morning when demand for appointments would be high. Although this was a ‘realistic’ approach in the sense that she understood it was best not to lose a customer she did not grasp all the implications of her decision. One student decided to dismiss the whole task as irrelevant because mistakes like this would never happen in an examination question. The sole purpose of functional mathematics for this student seemed to be to pass a test and attempts to relate mathematics to the students’ vocational interests were of no interest.

Combining mathematics with ‘common sense’ in a ‘realistic’ hairdressing problem seemed a good approach to teaching a functional mathematics curriculum but the students’ interpretations varied. Prior experiences of school mathematics and limited vocational experience affected their ability to apply knowledge to a ‘realistic’ situation and led to some very different results depending on the assumptions made by individuals.

For this group of students the qualification at the end of the course was relevant to their route towards a successful career because it was a college requirement for progression to the next level of training. Achieving a pass in the examination also represented an improvement in skills for some students whilst others felt they had not gained anything. Their starting points, in terms of existing qualifications, contributed to individual perceptions of the relevance of the course.

Diane:	What does that qualification mean to you two?
Rhiannon:	A lot. Because I didn't do my exams at school so… just came here and got a grade here … it's better than having nothing.
Zara:	Well I suppose it does mean summat because I never went to school and now I suppose I've got qualifications in maths.

For Zara and Rhiannon any qualification in mathematics represented an improvement on their current situation but for Keira, who already had a GCSE grade D, her Level 1 pass in functional mathematics had little apparent value.

> I got a D in my GCSEs and got a D in the exam that I did so there was no point on doing the exam that I did here because I've got the same grade. Because it wasn't the higher paper or anything so I'm on the same level.
> (Keira, Hairdressing)

In contrast Ellie felt that taking a functional mathematic course in college had been useful anyway because of the amount she had learned.

> I've learned loads more. I've learned more than I did in school and I was in school for what? Four years. I think I've learned more in the past two years in maths than I have in the last four years at school.
> (Ellie, Hairdressing)

The relevance of functional mathematics seemed to depend largely on the students' prior attainment and whether they believed they needed to improve. Whether students actually needed the skills for their adult lives or careers was a subject of some debate and early opinions changed as they advanced through the course.

Diane:	Did you feel when you started this year that you needed to do maths? Did you feel that was something you needed to do?
Leanne:	I didn't.
Ellie:	I didn't think we'd need it until we actually did it.
Leanne:	Yeah.
Ellie:	Then we could see how much more we needed to learn for it. Because we was all like we don't understand why we've got to do maths. If we didn't I don't think we would know half of what we need to learn.

The functional mathematics course became relevant for Ellie and Leanne as they began to see the need for mathematics in their future employment. This was something that Richard reinforced through his constant reference to the uses of mathematics in hairdressing. The students were clear that they would need to use mathematics and readily provided examples of estimating angles when cutting hair, calculating ratios when mixing hair colours and using time when planning schedules. Ellie and Leanne were enthusiastic about this approach to mathematics and explained some of the links made to hairdressing or everyday life.

Ellie:	Yeah, he always puts it into a problem where he would say if you was in a hairdressing salon how would you do this? How would you solve this? What ratios would you need on that?
Leanne:	Or a supermarket, how do you figure out like you know…
Ellie:	It does it to everyday life problems.
Leanne:	If you give money in do you know how much change you're giving back and all like that? He does it with us with stuff like that.

Although there were usually connections in Richard's tasks to real life situations it was the links to hairdressing that most students found most convincing. The exception was Keira, who was more concerned about the relevance of the tasks to the examination than the usefulness of functional mathematics in relation to her vocational area as she explained in the following conversation.

Keira:	I don't get it in this college.
Zara:	I don't get any maths.
Keira:	It's how it's worded and we should do practice exam papers.
Ellie:	We do.
Keira:	We've only done one of them though.
Zara:	But that's not a proper one.
Keira:	You know when you get past papers and how they're set out and that, they're not like that.

Richard's unstructured questions and open-ended problems were a contrast to her experience of school mathematics and she was unconvinced about these methods. In this group the relevance of functional mathematics was a topic on which the students were clearly divided.

Ellie:	I remember at school they said you need it when you go to the supermarket because when you get the little labels that says how much it is you've got to think how much of this and I think I'm not going to do that, not going to work out the Pythagoras of something am I?
Rhiannon:	Yeah, but if you want it you'd get it.
Leanne:	Yeah but if there's something off you don't need it to work that out.
Ellie:	Yeah but they normally tell you how much it is, it's like price drop. It tells you the price what was £15.99 now £4.99.
Rhiannon:	But then you've got to work out how much all your stuff comes to together but the till does that for you anyway so what's the point.
Zara:	Yeah, what's the point?
Leanne:	But you've got to give them how much money they ask for.
Rhiannon:	It says on the till.
Leanne:	Yeah but you're not…
Rhiannon:	Your change, it says how much change you're given.

Leanne:	No, but…
Rhiannon:	That's the only good thing about where that I work. It tells me how much I have to give them. I used to have to get a calculator because…
Leanne:	But you've still got to count it out. It's not going to count it out for you is it?
Rhiannon:	Yeah, but it's easy to add like £4 in £1 coins together and 25.
Keira:	That's just basic.

Their perceptions of the relevance of different contexts were explored further in the second term when the focus group were provided with three contextualised tasks to discuss. The comments they made demonstrated the difficulties some students had in seeing mathematics as a part of everyday life. Some students were of the opinion that mathematics could be avoided in life and work situations. As Rhiannon suggested "I have a till. That does it for me". Others based their judgements on limited experience or unrealistic future expectations. For example, given a task about cashing up the takings in a till at the end of the day (see Appendix 1.9, page 281) some students felt this was irrelevant since this would not be within their job role but others argued against them.

Diane:	Do you think that's relevant to you at all that particular sort of task?
Rhiannon:	Um, no.
Ellie:	It could be on reception.
Rhiannon:	I don't really think it is.
Leanne:	I'd say yeah.
Zara:	Yeah but you're not training to be a receptionist are you?
	(later in the discussion)
Ellie:	We have got time on reception so we've got to be able to do it.
Rhiannon:	You don't have to be a receptionist.
Leanne:	No, but if you're earning money in a job and you can't afford a receptionist then you're going to have to do it if you're a manager or like a senior stylist. Stylists can do it can't they? So, yeah.

Another task, about hair dyes (see Appendix 1.9, page 277), offered some possible links to salon practices and seemed likely to be authentic since it was written in consultation with hairdressing staff at another college. The students rejected the task as irrelevant and their reasons are given in the extract below.

Zara:	No. No use to me whatsoever.
Rhiannon:	You don't measure the millimetres of the hair.
Ellie:	You judge it.
Zara:	I would say that.
Ellie:	You use less than what you do and then you mix if you need more.
Zara:	That's not useful at all.
Rhiannon:	We don't even use tubes no more, it's a pump.
Ellie:	You just mix what you need.

Zara:	It’s half and half.
Rhiannon:	It’s not millimetres and …
Zara:	You do half and half and if you need any more you mix what you need.

Firstly, there was a misunderstanding of the question that presented difficulties. They assumed the hair was being measured (in mm) when in fact it was the dye that was being measured (in ml). Simple confusion over these mathematical symbols became a barrier to seeing the relevance of a task that other groups had felt was really useful to them.

Secondly, the reference to tubes of dye provided another reason for a swift rejection of the task as irrelevant since they were using pumps (dispensers) rather than tubes in their salon. With wider experience they may have realised that it was common practice to use hair dyes supplied in tubes and their training salon was an exception rather than the norm. In addition, their limited experience of mixing only simple ratios at this point in their training meant they failed to appreciate the need to understand more complex ratios or measure accurately.

One of the hairdressing tutors later explained the importance in a salon of measuring accurately, avoiding wastage and being able to solve problems that may arise. As an example she described a recent incident in the training salon when the electronic scales had failed part way through measuring some hair dye into a dish. The students were considering throwing the dye away and starting again because they were unable to find a way of re-measuring the dye and adding the second colour. Finding a solution involved some additional weighing (of an identical dish) and a simple calculation but the non-routine nature of the problem presented a challenge to the students.

The need for certain mathematics in their careers as hairdressers was clear but some students felt this was just basic mathematics that they already knew. Being able to solve problems and having the confidence to apply mathematics in non-routine tasks in the workplace were skills that several hairdressing staff identified as important but most of the students did not yet recognise these as part of their intended career.

Richard’s approach of focussing on solving problems in ‘realistic’ scenarios related to hairdressing was based on the concept of mathematics as a ‘tool for life’ and this worked well for some students like Leanne and Ellie despite their initial reactions. Other students, like Rhiannon, still disliked the subject and were keen to dismiss any suggestions that it may be relevant to her future life. As she explained:

> But now you don't need like to know it in your head do you? Because those tills, they do it for you. (Rhiannon, Hairdressing)

The outcomes for these students were varied in terms of both attainment and attitude. Rhiannon passed her functional mathematics test at Entry 3 but still disliked the subject. She would, reluctantly, have to take functional mathematics again the following year to improve further. Zara passed Level 1 and attempted Level 2 so she could avoid taking functional mathematics for a third year. Although still lacking confidence, in her two years at college she had learned a substantial amount of the mathematics she had missed by not attending secondary school. Ellie and Leanne were delighted to pass their tests, enjoyed the experience of learning functional mathematics and were more confident in their ability to use mathematics. Teresa became increasingly frustrated, stopped attending functional mathematics classes and her attainment in mathematics remained unchanged.

4.4 The main features of the case studies

The three case studies in the preceding sections show the main student responses to functional mathematics that emerged from the research and suggest some of the influences that shaped their opinions. These could be broadly divided into influences from socio-cultural factors and from perceptions of the relevance of functional mathematics, which together acted to encourage positive attitudes towards functional mathematics in some student groups or resulted in a continuation of existing negative responses for others.

Attitudes seemed to become more positive in lessons such as Lindsay's and Richard's where social structures contrasted with school classrooms. Most students in these classes felt they were treated with respect, had more equitable relationships with teachers and had often developed strong personal relationships with these staff that seemed to facilitate both greater engagement with learning and gains in understanding. Values associated with the adult learning environment in college were evident in these classrooms and contributed to a different experience of learning mathematics compared to school. In David's lessons the rules and relationships had more similarity to a school mathematics classroom and the implicit values within his teaching approaches contrasted with those within vocational sessions. His students retained negative attitudes towards mathematics and replicated established patterns of behaviour associated with previous learning experiences.

Students' relationships with their peers were important and they were aware of making social adjustments in their transition between contrasting educational institutions. There was some sensitivity to social tensions in groups and these sometimes had an impact on the learning experience, as illustrated by the case study of Richard's Hairdressing group. In addition, students were often affected by their previous experiences of mathematics through the legacy of failure, negative emotional responses and low self-efficacy that accompanied them into college. Teachers such as Lindsay and Richard, who had some understanding of the issues for students and of the broader learning environment in which they were teaching, took steps to address these affective and cultural aspects of the student experience, with some success. David's approach seemed to focus primarily on cognitive development, overlooking the social or emotional influences in the learning situation and bringing little change in student engagement or understanding.

Perceptions of the relevance of mathematics also contributed to student levels of engagement with functional mathematics. All three teachers in these case studies were using the same stated curriculum but their interpretations and teaching approaches varied. Some students were presented with a new view of mathematics as a set of useful skills that related to their personal lives, interests or vocational areas. Where functional mathematical tasks appeared, from a student perspective, to use authentic descriptions of contexts with meaningful connections to their personal experience, then they began to understand how mathematics was relevant to their current lives or intended employment destinations.

The key features of these three cases studies form a basis for further analysis of the factors that were influential in the student experience across the whole study. In the following chapter, these features become important threads within a cross-case analysis which identifies the main themes within the full set of case studies.

Chapter 5: Analysis

In the previous chapter, each case study highlighted key features in the experience of the group that were significant but the overall picture was complex and multiple interacting factors could be identified for each individual or group. In this chapter a cross-case analysis explores some of the strong threads that run through these case studies. These threads comprise the following four main themes:

1. Students with history

Students' initial approaches to learning functional mathematics were influenced by *attitudes and emotions* that were largely dependent on their *prior experience* of learning mathematics in school. Established *patterns of behaviour* were sometimes replicated in college functional mathematics lessons and *prior attainment* in mathematics contributed to individual students' expectations of their learning experience with functional mathematics.

2. The transition from school to college

The transition to vocational training brought students into contact with a *different environment* with changes in both freedoms and responsibilities. Adapting to the *vocational culture* and different *approaches to learning* involved some social adjustments and the adoption of new values that affected their views of functional mathematics lessons. Certain *organisational structures and policies* for functional mathematics had an impact on teaching approaches and student attitudes through constraints on opportunities or requirements imposed.

3. Students' perceptions of mathematics

Students entered college with existing *images of mathematics*. Their experiences in college either reinforced existing views of the subject as an *academic discipline* or presented an alternative concept of mathematics as a *useful 'tool for life'*. Working practices and systems in vocational departments contributed to the formation of impressions that functional mathematics was either an *additional isolated course* or an *essential integrated component* of their programme.

4. Building connections in functional mathematics lessons

Teachers' *interpretations of the functional mathematics curriculum* varied, leading to a range of *different teaching approaches* and student experiences in the classroom. Lessons that had positive effects on students often focussed on *supporting the individual* and the development of strong positive *teacher-student relationships* encouraged student engagement. Using *contextualised tasks* to link mathematics in meaningful ways to familiar scenarios outside the classroom increased student *perceptions of relevance* because they began to understand the *usefulness of mathematics* in life and work.

The analysis discussed in this section uses the three main case studies described earlier but also draws on a much wider data set of cases and other data. Here the threads are pulled apart into the four themes in order to understand the key issues; however the themes are overlapping and the factors within them are often interlinked. Within the sections, examples in the form of short case portraits represent a more holistic view, and show how some of the threads are woven together into the fabric of the student experience. Reference to student groups will be made using the codes listed in Appendix 2.4 (page 285) which indicate the general vocational area and college for each case study (e.g. PA2 = Public Services, College A, group 2).

5.1. Students with history

5.1.1 The impact of previous experiences on attitudes towards mathematics

> "I don't think anybody likes maths to be honest" (Matt, PA2)

Matt's statement about his feelings towards mathematics was similar to comments made by other students in their first focus groups. His attitude was based on prior experience of the formal discipline of mathematics he had encountered in school but this had left a legacy of disaffection that lingered beyond the learning situation. In their interviews, functional mathematics teachers frequently referred to an inherent widespread dislike of mathematics amongst students that they believed originated from previous experiences in school but affected attitudes in college. For these teachers, one of the problems of making progress with students who had not enjoyed their earlier experiences of learning mathematics was the challenge of overcoming negative attitudes that were rooted in previous situations.

Many students talked about disliking mathematics and referred to discouraging experiences of learning mathematics in school. In the first individual focus group activity, over half of the students indicated they had only 'occasionally' or 'almost never' liked maths in school (58 out of 101 respondents) and 38 of these felt they had ‘almost never’ liked maths. These results indicate that, for the students in the research, mathematics was not widely liked in school although perhaps not as universally disliked as Matt had assumed. The large number of students who had ‘almost never’ liked mathematics, however, suggests that negative responses to mathematics tended to be strong and persistent in their experience rather than transient.

Students’ statements about disliking mathematics in school were frequently accompanied by a description of their experiences of learning mathematics, rather than a judgement about the subject itself, indicating that their reactions were strongly associated with the learning situation. Before exploring references to student from other groups about mathematics in school, Damien’s earlier comments warrant some further examination.

> I used to have an extra other lesson but when I was in the proper lesson they used to teach and I used to put my hand up after he’d spoken to see if he could explain it again but then he wouldn’t because he said “Well I can’t because you’ve already listened to me once. You can get on with it” but I never used to be able to do it you see but I never used to get extra help and then I did a little bit but not as much as I did in college. That’s why I’ve found it easier this year. (Damien, PA1)

The dominant memories of mathematics in school for Damien focus on his requests for help, followed by refusals from the teacher and a failure to make progress. For him, mathematics was not an easy subject but being able to understand was important. Although he received extra help in the form of additional lessons, he was also keen to be successful with the mathematics taught in the main class. In the presence of his peers, this would contribute to his sense of belonging and social acceptance in the mathematics classroom.

Damien had needs that were not being met and he attributed the blame for his difficulties to his teacher. He had no power to change the situation when help was not forthcoming and his own efforts to understand were unsuccessful. These recollections of being neglected are associated with a lack of personal agency and control over the learning process with which Damien expressed some frustration in the focus group.

Anna was a student who had also felt neglected in classes at school.

> Yeah, they ain’t got time have they because they’ve got that many students so they just used to push you aside if you didn’t get it or put you in a lower group or whatever. (Anna, HB2)

Like Damien, Anna saw the actions of teachers in school as contributing to her failure with mathematics but identified organisational issues as the underlying cause. Her reference to the large number of students in a class and the practice of sending weaker students down to a lower set would suggest that she attributed the blame to systemic sources rather than personal teacher decisions. She understood that teachers with large classes did not have the time to devote to individual students, particularly those who needed significant additional input to make progress, and perceived the school system of ability grouping as a convenient means of dealing with the problem.

Anna also made a comparison between herself and other students in the class. She described a differentiation between pupils on the basis of ability that favoured the more mathematical students and overlooked the needs of those who required extra support. From Anna's position, the strong students were in a privileged position within these lessons and understanding mathematics seemed to be the key to acceptance in this classroom community. Like Damien, Anna experienced a sense of being unwanted and not really belonging in this learning community accompanied by a similar lack of personal agency.

The comments from Damien and Anna illustrate some important aspects of the experiences of students who disliked learning mathematics in school because it was associated with unproductive attempts at learning the subject. A failure to make progress with mathematics in a classroom situation led many students to identify themselves as a person who could not do mathematics and did not belong in a community where learning mathematics was the main focus. Students such as Damien and Anna viewed a functional mathematics course in college as a new opportunity to address the deficit in their skills but the legacy of previous failures remained. Some of these barriers to re-engaging with the subject resulting from previous experiences will be explored further in the following subsections.

5.1.2 The legacy of negative emotional experiences

One group of Beauty Therapy students (HC2) expressed their initial feelings about taking a functional mathematics course in college as follows:

Diane:	So how did you feel when you found out you had to do functional mathematics?
Nina:	Absolutely gutted.
Isla:	I didn't like it.
Jess:	I thought I was going to cry.

These three students had spoken previously about finding mathematics difficult in school and how they had disliked the subject but there was evidence of strong negative emotions in their reactions to the prospect of taking a functional mathematics course in college. Being unable to understand mathematics in the past had been an uncomfortable experience but the accompanying emotions were so closely associated with learning mathematics that they resurfaced when faced with taking another mathematics course, even in a different environment. Their emotional responses were deeper than a transitory response to a specific situation in the past, leaving a legacy that affected their expectations of college mathematics lessons.

Other students indicated their low expectations and self-efficacy beliefs by speaking about their assumptions that any further attempts to learn mathematics would only replicate the negative experiences of the past, producing similar outcomes and emotions. In contrast, Carrie had a poor experience of school mathematics lessons but explained the change in her feelings within college.

> But I feel like at school people would laugh at you if you didn't know something in maths whereas here people just, you know, everyone's just like 'Oh I don't know it either' so… (Carrie, HB1)

In school Carrie had felt surrounded by students who seemed to understand mathematics and she thought may not be sympathetic to her difficulties. She was emotionally sensitive to the reactions of her peers and feared exposure of any mistakes but in college she had found security in a contrasting classroom environment. Like Anna, her emphasis on comparisons between herself and other students indicates the importance of being socially accepted and comfortable within the classroom community. There were, however, negative effects from peers that still affected some students in college and one example will be explained as part of the following subsection.

5.1.3 The behavioural consequences of negative experiences

The need to be identified with a social group and share the values adopted by others were strong influences that affected student behaviour. For example, data from the first term activity indicated that being distracted was a common occurrence in school mathematics lessons (68 out of 101 responses from students indicated they were distracted half the time or more). In the case studies, this aspect of classroom experience was raised by Sian (PC1), who talked of being distracted easily in school but also admitted to continuing with similar behaviour in college mathematics lessons. The cycle of poor achievement, disinterest and disengagement seemed hard to break. Although Sian blamed others for her lack of engagement she appeared to make little effort to change this habitual behaviour. Having developed a strategy to avoid learning mathematics, she found it easier to continue with this approach. There was a lack of resilience that led to choosing inactivity and avoidance over an effort to understand mathematics, despite the inevitability of the result.

Other students who had encountered difficulties with mathematics in school often found their own ways of coping with the situation and had established patterns of behaviour to avoid engagement with the subject.

> Because I didn't understand it, towards the end I gave up with it and concentrated on more that I did understand, you know what I mean, to get a better grade and stuff, but in maths, because I knew I was going to fail and I knew I didn't understand it I think that's what made me give up on it. (Eva, HB2)

Eva's problems in understanding mathematics resulted in a rejection of the subject as a one that was too difficult and not worth the effort. Like Sian, she avoided mathematics rather than persisting with efforts to understand it, although her course of action was different. For Eva, the difficulty of the subject and a lack of resilience led her to a definite decision to make no further effort. It was her own deliberate avoidance that determined her destiny as a failure in mathematics but she accepted this without trying to blame others. Self-efficacy was low and there was little expectation that anything would change.

Students who had disliked mathematics frequently employed strategies to avoid the subject rather than engage with it. Sian deflected the blame for her lack of engagement to her peers but others believed the root cause lay with their teachers.

> They pick the people and think "I'm going to help them the most" kind of because they're going to get a high grade but "I'm not going to help them" and when we fail it's "Ah, you could have done better". But it's really them who's not explaining something. And when they're not helping us and they're helping them we're getting distracted and being loud and I ended up getting kicked out of lessons. Basically that's all down to the teacher giving them people attention and not giving these people attention. So in school I don't think maths is good.
> (Marion, PA2)

Marion perceived the apparent neglect in class as a type of social discrimination by the teacher that resulted in her being unable to understand much of the work. Her periods of inactivity and low level of engagement seemed to lead to a cycle of distraction, unacceptable behaviour and eviction from the classroom that further reduced any learning opportunities.

Frustration and stress were mentioned by several groups in relation to their emotional responses to mathematics in school and active avoidance was sometimes discussed as a means of dealing with a stressful classroom situation. For example, Jake (PA1) referred to walking out of the lesson when stressed, suggesting that the need to escape from the immediate situation was stronger than fear of the consequences.

In other cases, students exhibited a more passive avoidance involving quiet non-participation. This sometimes resembled a carefully constructed art with the aim of being overlooked in a busy classroom as illustrated by the following example from a lesson observation in college.

> Mollie, who was on a Level 2 Hairdressing course, attended functional mathematics classes taken by Richard. On the occasion of the first observed session, she arrived slightly late but had time to spare before the lesson commenced because Richard decided to wait for other students who had still not arrived. The lesson was held in a multi-purpose room with computers on work surfaces around the perimeter and set of tables in the central area. Mollie chose a seat in front of a computer with her back towards Richard so she could avoid interaction. Whilst other students enjoyed a relaxed conversation with Richard, Mollie was more intent upon applying mascara using the blank computer screen as a mirror. When the lesson started Mollie continued to attend to her make-up for some time. Eventually she turned around and listened for a while to Richard's lesson introduction but soon lost interest. When he offered pens to students who had forgotten them, so written work could commence, Mollie took no notice. She returned to her make-up and, once completed, spent time adjusting her hairstyle by re-arranging multiple hairpins. Eventually she decided to let down her hair, brush it out and start again with the hairpins. When she finally turned to the worksheet that had been handed out she had missed most of the verbal instructions, struggled to find a pen and clearly had little idea what to do. Her half-hearted attempt involved copying a few answers from a friend before giving up and concluding that it was too difficult. Mollie later explained that she couldn't do mathematics. Her avoidance tactics, developed in school and replicated in college, made it likely that this conviction would remain unchallenged in the near future.

Mollie had developed a means of avoiding mathematics that relied on keeping a low profile in a group where others demanded attention. From subsequent informal conversations with

Mollie it seemed that her reluctance to engage with learning was based on a belief that she could not do mathematics. Her lack of resilience was a phenomenon demonstrated by other students within this section, such as Eva and Sian, who accepted the inevitability of failure rather than sustaining any effort to improve. The results of these actions had effects on learning but the impact of failure itself, evidenced by low attainment, was also significant and will be further explored in the following subsection.

5.1.4 The effects of prior attainment on attitudes

For most of the students in the previous section their perceptions of a failure to understand mathematics were accompanied by low attainment in the GCSE examination. GCSE grades were commonly used by functional mathematics and vocational staff in their interviews as convenient ‘labels’ to identify those who were ‘failures’ compared to those considered to have achieved a satisfactory standard. This distinction between success and failure was important to students and the following short portraits of five students from the main case studies will show how their prior attainment in mathematics affected their approaches to taking a functional mathematics course in college.

Ryan (PA1) already had a grade C in GCSE mathematics and could see no reason why he needed to do mathematics. Although later his views changed, his initial response was that this was a subject he would not need to use in the future and therefore did not need to study any more.

Simon (PC1) also had a grade C in GCSE mathematics and failed to see why he needed to take another mathematics course. His response was to attend the lessons but not necessarily participate. The departmental policy that required him to take a functional mathematics course resulted in him deliberately avoiding the work whenever he didn’t feel “in the mood”, making little progress and sometimes disrupting others.

Tina (PC1), from the same Public Services group, had also achieved a grade C in school and could see no point in having another qualification in mathematics. Her response was a more passive acceptance that doing the functional mathematics course was a requirement so she would have to comply. She quietly completed all the written work expected in lessons and was frequently allowed to leave early as a reward.

In contrast, Damien (PA1) welcomed the opportunity to improve. He felt his grade E in GCSE mathematics would not be sufficient for his intended career in the Fire Service and for him a functional mathematics course in college was a second chance to address the deficit in his mathematical knowledge. Despite his lack of success and a negative experience of school mathematic lessons he was keen to make progress and conscientiously applied himself to the task of improving his skills.

Sian (PC1) also had a grade E at GCSE but lacked Damien's motivation. She complained of being distracted in school and referred to being thrown out of lessons but was also easily distracted in college. Sian thought the only reason for taking a functional mathematics course was to gain another qualification that would allow her to progress on to the next Public Services course in college. Her response to functional mathematics lessons was to avoid doing any work and leave early whenever the opportunity arose.

The different responses of Ryan, Simon, Tina, Damien and Sian to functional mathematics were typical of the range of initial reactions of other students to functional mathematics in the research. Attitudes formed during their previous experience of learning in school were important but there was a clear difference in initial responses from students who had already attained a GCSE grade C and from those who had not.

Ryan, Simon and Tina failed to see the point of doing a functional mathematics course because they had already achieved a 'satisfactory' standard. Students who had a grade C or above often adopted a similar attitude with comments such as functional mathematics being simply a "waste of time" and "I think the people who have a grade C are doing it for no reason". Some, like Tina, reluctantly accepted the situation whilst others reacted more strongly. Attitudes of frustration and resentment were common, even if submerged under a façade of compliance, since there was an underlying sense of injustice at having to continue with a subject for which they had already attained an accepted standard.

Students with lower GCSE grades, such as Damien and Sian, seemed more affected by the influences of their past experiences. Damien's positive attitude, of welcoming the opportunity to improve, was evident in some low-attaining students but for many the desire to learn was constrained by lingering attitudes, emotions and low expectations from the past which sometimes proved difficult to overcome.

Achievement in mathematics was often associated with positive attitudes and emotions for students. Ellie (HA1) was of the opinion that "I think maths could be fun if you could know what to do” and Ryan (PA1) expressed a similar view with his statement “I’m quite good at it, so I like it”. Other students connected their dislike of mathematics to their apparent lack of ability with expressions such as “I can’t do it. That’s why I don’t like it” (Sara, HC1). There was a common view amongst the students that failure with mathematics was the cause of negative attitudes but success brought more positive attitudes and emotions.

For some students, however, an improvement in attainment alone was insufficient to change negative attitudes and emotions. Several students made statements such as “I just can’t do maths” (Zara, HA1) and “I’ve always found it hard” (Carrie, HB1) implying that their expectations of making any improvement were low. For example, in Richard’s Hairdressing group, Zara passed the Level 1 examination but concluded that her examination success was just a ‘fluke’ and she had learned nothing. With a history of non-participation and a lack of any qualification, even the achievement of a positive result for Zara seemed insufficient to change her belief that she could not do mathematics.

At this point it is worth noting that of the 103 students in the focus groups, only 78 declared a grade in GCSE mathematics and just over half of these had a grade D or lower (41/78) whilst a similar number had achieved a grade C or above (37/78), although most of these (30/78) were only a grade C. From discussions in the focus groups it became clear that some students did not declare a grade because they had not taken the examination whilst others preferred not to disclose the information, indicating this was a sensitive area. Due to differences in college and departmental policies all these students were taking a functional mathematics course. The implications of college policies will be explored further in Section 5.2.3 but, firstly, other factors in the transition from school to college will be discussed that had an impact on student attitudes and engagement with functional mathematics.

5.2 The transition into vocational learning in college

5.2.1 Changes in organisational culture

Students were aware of being in a different culture in college and readily identified contrasts with their experience of school. In this section comments from several case studies will be used to explore the main differences between school and college that were highlighted by students.

George, Neil and Abigail (PB2) describe the differences as follows:

Abigail:	Or you can go for a fag. We're allowed to go for a fag. We can go off of the premises at break and dinner.
George:	And you don't have to be here all day if you don't want to be.
Abigail:	We don't have a uniform.
Neil:	The best bit is if you need to calm down you can take yourself outside and like calm down without someone jumping down your throat at you. You can take your phone calls. You can go to the toilet.

These responses show the value students placed on the relative freedom they experienced in college compared to school. This was a common theme in students' comparisons of their past and current experiences and most students 'agreed' or 'strongly agreed' (87 out of 103 responses) that there was more freedom in college than in school. The freedom involved more opportunities to make personal choices and students welcomed approaches that were more flexible compared to the rigid rules that had controlled their behaviour in school.

George's and Neil's comments imply that there was freedom to leave class at any time in college but observations of lessons showed that this was clearly not the case although there were differences in rules and methods of enforcement in college. For example, although students did arrive late for lessons on several occasions, this behaviour was neither condoned nor actually punished. Teachers made their expectations clear and sometimes negotiated within boundaries rather than directly applied strict rules. Student perceptions of freedom might therefore be better interpreted as an awareness of less restriction and control from the college over their lifestyle rather than a complete absence of rules.

Harry and Jed (CA1) agreed that there was more freedom in college but provided a different reason for their conclusion.

Harry:	Yeah, college is not something that you have to do but it's better than school. Obviously it's a lot better … like… but they're more open and flexible. And the times as well…
Jed:	Yeah, because you don't actually have to come very many days on your course do you?
Harry:	It's just three days a week.

The timetabling of vocational courses often meant student groups would only be attending college for four days a week, or less, although sometimes these were protracted days compared to school. Jed and Harry appreciated this reduction in the restrictions imposed on their lives by the college. Although most students 'agreed' or 'strongly agreed' that they found their course interesting (91 out of 102 responses) and wanting to "improve my education" was the second most popular reason for coming to college in the student rankings, many seemed pleased that their education was no longer a daily, compulsory activity occupying the entire week. Their vocational education seemed valuable but there was also an attraction in having less restriction from authority and more independence.

Choice was a subject raised by students in several different focus groups.

> I think the thing about college is you choose what lessons you want to do whereas at school you're forced to do it. You've got no choice. I think that's why a lot of people come to college. (Sara, HC1)

There was a closer connection in college between students' personal choices regarding their education than there was in school. The freedom to choose was not entirely without restriction, since their prior attainment had largely determined their place on a vocational rather than an academic pathway and also affected the level of vocational programme they could take. In their rankings of reasons for attending college, being interested in the course emerged as the most common reason given by students, followed by wanting to improve their education (See Appendix 3.2, page 288). Most students in the focus groups seemed to believe they had made their own decisions even though their choices had clearly been restricted by course entry requirements and, in some cases, by parental pressure to continue in education. These choices, however, contributed to a perception that they now had greater agency and control over their pathway and made them feel more favourably disposed towards their college programme than their general school education, about which there had been little option.

The students had entered an organisation in which personal responsibility, independence and individual choice were encouraged and these values had begun to permeate their approach to learning, as Sian explained earlier.

> The difference in school and college that I noticed is that in school you get forced to do the work. In college … like I used to always argue with the teachers, but in college if you don't want to do it it's your fault.
> (Sian, PC1)

The strict enforcement of rules in school meant that she felt unable to avoid work but her response was to resist rather than co-operate with authority and there was friction with a system that imposed values and demanded compliance. In college, she experienced a freedom to make personal decisions about her participation and, although she realised this implied acceptance of responsibility for the consequences, she welcomed the opportunity to make a personal choice.

The absence of conflict or punishment as a result of personal choices was an aspect of freedom in college that was important for students. Disagreements with teachers seemed less frequent in college than in school, as Ryan explains.

> I feel like because they're 'softer' it makes me want to like comply more with them instead of getting like – usually I have my shirt hanging out and our teacher was really strict on uniform and he would always take me out of the lesson and I would miss 5 minutes at the start because I was getting shouted at for being scruffy. So then I was like I didn't really want to work and work with him because he was just a dick.
>
> (Ryan, PA1)

Ryan's non-compliance with a strict uniform code led to confrontations that affected his attitude to mathematics lessons and had implications for his progress. Despite demands for a personal change in appearance, Ryan did not see the reason for this attention to detail and the outcome was a diminishing respect for his teacher rather than compliance with the rules. Their difference in values about uniform resulted in a damaged relationship and a decrease in Ryan's engagement with learning in the classroom. A less rigid approach to discipline in college, however, encouraged him to comply rather than rebel. Like Sian, he appreciated being in a position where he could begin to make personal choices about his behaviour rather than being forced into situations in which he was uncomfortable.

The relative leniency of the rules in college made students like Ryan and Sian feel they were being treated in a more adult manner. This was an aspect of college life frequently quoted by students as a welcome change in their transition to college. As shown in Appendix 3.2, (page 288) many students 'agreed' or 'strongly agreed' that they were treated like adults in college (74 out of 101 responses) and were treated better in college than in school (76 out of 103 responses).

Students particularly referred to a difference in their relationships with college staff compared to those with teachers in school.

> You can actually have a conversation with your tutor instead of like what it was like at school with your teacher. You couldn't call them by their first name. (Kerry, HB1)

Using first names was indicative of a change towards more open communication and a less formal relationship with teachers. Most students 'agreed' or 'strongly agreed' that in college they did "get on with the staff" (83 out of 103 responses) and many students felt they liked their functional mathematics teachers in college more than in school (64 out of 103 responses). As Ryan and Darren explained earlier, they liked and respected Lindsay because of her non-confrontational approach and positive attitude, which contrasted with their expectations but had the effect of encouraging them to work with her.

The effects of student-teacher relationships will be explored further in Section 5.4.2 but the aspect of general social acceptance was important in students' transitions to a new environment, as Marion explained.

> And you get to college, yeah, and you make friends don't you? When I first came to college I walked in the class and I was looking at those people and I thought "Oh my gosh, who are these people?" and I thought "They're not going to make good friends. We're just going to clash completely with different people" but then everyone in our class gets along. So it's alright. (Marion, PA2)

Marion gave the appearance in the focus group of being socially confident but she had been nervous about finding her place in a new group of strangers and uncertain about the outcome. The possibility that personalities would conflict and that characters would not be able to work together seemed a very real possibility. These social adjustments were a major part of the transition into college but after several weeks most students 'agreed' or 'strongly agreed' that it had been easy to make new friends (83 out of 103 responses), although their comments indicated that this had not been achieved without some negotiation.

These newly established social relationships also had an impact on individual learning. For example, students were exposed to a situation in which they were sometimes working in mixed-age groups. Teachers remarked on the positive aspects of this integration of mature students with school-leavers, due to beliefs that the attitudes of mature students, often perceived as more serious and committed, had a positive effect on the younger students. In the case study of Richard's group, however, Teresa actually had a negative impact on some of the class, due to her problems adjusting to college and her personal difficulties with functional mathematics. Learning depended on others within the social structure as well as the attitude of the individual.

Elaine, a mature student on a Construction course (CC2) explained how the social situation within the class was important for her in the learning process.

> *Diane*: Do you feel any more positive now?
> Elaine: Um, yeah, because obviously I know the group a lot better which probably helps. Because there's no point in me sitting in a group if, you know, you can't talk to them or ask them for help or anything. Whereas with the group that I'm in, we all help each other out and

> stuff, which is better so, yeah, I think now is a lot better than when I first started in September.

Informal interactions and support from fellow-students were an essential part of the learning process for Elaine and she did not expect her understanding to be solely dependent on input from the teacher. The freedom to interact, discuss and help each other was a means of enabling learning, so establishing good relationships that could be used to facilitate understanding was essential. Teaching practices observed in the study varied but, for many students, a supportive classroom culture in which they could work together and learn from each other was important for functional mathematics.

This approach reflected some of the practices observed and encouraged in vocational sessions. Activities in observations of Public Services sessions often involved a co-operative, team approach to tasks and strong relationships between students were vital to certain activities such as expeditions. The use of informal discussion as a means of peer learning was also common practice for those who shared work spaces in Construction and Hairdressing. These approaches were embedded into vocational learning so students expected to support each other and work together informally. Effective learning in functional mathematics classrooms seemed to be dependent on an awareness of these aspects of the vocational culture and the adoption of similar values into the learning process.

5.2.2 Adapting to the vocational learning environment

Students often referred to their general experience of college in positive terms compared to their time in school. With respect to their vocational choices, most students ‘agreed’ or ‘strongly agreed’ that their course in college was interesting (91 out of 102 responses) and that they liked the subjects they did (89 out of 103 responses). In this section, a short summary of an observation in the Beauty Therapy training salon of a student group (HC2) will be used to illustrate some of the distinct features of vocational courses and how these contributed to changes in students’ values, roles and expectations of learning situations.

> The morning session was underway and activity was already taking place when I was invited into the salon. The students were giving facial treatments to clients, who were mainly family or friends. This involved individual skin consultations and one-to-one practical work with the clients. Some students had been paired with others from the class to practise the facials due to a shortage of clients. One student, Nina, was demonstrating the treatments on a ‘doll’ (artificial head) to students

> who had missed the previous session. Nina explained how there were several stages in the facial and each had to be completed properly. She was aware that the full treatment should take 30 minutes and that extra time would lose money in a real working situation. Another student, Gemma, was acting as the salon manager. This involved replenishing products when necessary, keeping records of the times taken for treatments and generally making sure the salon was running smoothly.
>
> Quiet, relaxing music was being played and each student worked individually with their client at their own couch. Several times during the session students who were working together were reminded by the teacher to only talk quietly and politely. Those with real clients were expected to talk solely to their client and not chat to other students. Maintaining professional behaviour was an important aspect of salon practice. All the students were wearing clean uniforms and had taken care over their own personal appearance. After completing her demonstration Nina explained to me that students were expected to maintain their own uniforms, have their hair tied back and keep jewellery to a minimum. Apart from controlling the atmosphere, the vocational tutor watched and advised, acting as a guide and source of further information when necessary.
>
> At the end of the morning session the clients were accompanied back to the reception area whilst other students cleared up the salon. After a short lunch break the students returned promptly to prepare for the afternoon session. They entered the room chatting loudly but once roles were allocated by the tutor and clients were ready to be collected from reception they pulled the blinds down, switched on the soft music and quickly re-created the atmosphere of a professional salon. The transformation from students to professional beauticians was clearly evident in the few minutes that that preceded the entry of new clients to the salon for the afternoon session.

This observation was notable for the way in which the students were expected to adopt professional standards of conduct within the salon, which contrasted with their normal informal student behaviour. Learning to adopt new roles formed part of their training and was an essential part of preparation for the workplace. Showing politeness, care and personal interest to customers were valuable skills that had to be learned and maintained. The training salon was designed to simulate a realistic working situation using the same products, equipment and basic practices as a commercial salon but students still had to learn to become professionals.

Working in the training salon involved responsibilities for students to make decisions about treatments, behave professionally and sometimes supervise their peers. The level of responsibility when dealing with real clients was significant compared to classroom learning.

Within the salon there were strict rules regarding uniform, personal appearance and conduct but there were also freedoms. Students were expected to focus on their client during the session and avoid unprofessional chatter with other students but walking around to collect equipment or products and consulting with others for support or advice were accepted working practices.

The practical skills used in the salon were closely connected to theory learned in other sessions. Procedures for treatments had to be memorised and students were expected to recall relevant theory during consultations. The vocational tutor later explained how an integrated approach worked well, with theory taught in the salon prior to a practical session or with constant reference to theory in a practical situation. Theory and practical may have appeared as separate items on student timetables but the delivery was linked and staff viewed these as integrated parts of one programme.

The tutor role in the salon during the practical session was mainly to observe, support and advise. Students requested advice and help when necessary and occasionally the tutor would intervene to make suggestions regarding the practical treatments, correct errors or control deviations from professional behaviour. Although she represented the definitive source of knowledge, students learned from each other as well as from their tutor.

Observations in other vocational areas showed some similar approaches to learning. Students worked within frameworks of rules that related to health and safety requirements and professional occupational standards, yet had the freedom to make individual decisions about their work. These learning situations were characterised by several common features that contrasted with student descriptions of their formal education in school. In summary:

- students were expected to take a personal responsibility for their learning
- students sometimes took personal responsibility for clients or other students
- the learning experiences were often focussed on developing practical skills but knowledge gained from theory sessions was integrated into activities
- theory and practical were often intertwined into substantial tasks, with multiple elements and time scales that stretched over days or weeks
- there was freedom to work to an order and pace that suited the individual within a given time scale.

- values relating to the goal of employment were evident in the sessions, influencing the activities and working practices
- there was a physical space and freedom of movement around the salons, workshops or even the classrooms used for vocational sessions.

In their transition to college students had to adapt to these changes and learn how to deal with new learning situations with different responsibilities. This seemed to emphasise the differences between vocational learning and functional mathematics lessons where more formal approaches were often retained. The implications for functional mathematics teaching will be further explored in Section 5.3.3 but these observations clearly indicate that students were quickly becoming familiar with a new environment with contrasting values to those in formal education.

5.2.3 Influences from organisational policies and approaches to functional mathematics

Policies for functional mathematics in the three colleges all involved partially devolved responsibility to vocational departments or 'schools' even when there was a centralised staffing structure in place. One manager described the dual policy approach as follows:

> We have put together a policy which covers the staffing, the delivery, quals on entry, guided learning hours, the policy, actually within the school, because schools will have their own specific policy but that's based on the guidelines we have got in this strategy plan we've put together. (Manager, College A)

Policy was developed at both senior management and departmental level but enacted policies varied between departments since, in practice, many decisions were made at departmental level rather than by managers with cross-college responsibilities. The particular elements highlighted by this manager were common features of policies in the other colleges: providing resources to support teachers, supplying guidelines about options for students based on their prior attainment and specifying the hours allocated for functional mathematics sessions based on current levels of government funding. These reflected a response to practical issues such as staffing and teacher support but also a need to respond to government recommendations and national funding guidance. Functional skills managers in the case study colleges also provided structures for internal moderation and recommendations regarding student examination entries.

The strong external and financial influences meant that college policies did not necessarily reflect the needs of students, even though managers stated that this was important. In this section, three particular college policies will be examined that emerged from the research as the main influences of significance in the students' experience of functional mathematics:

- Policies on which student groups or individual students should take functional mathematics
- Policies on the level of examination entry to be taken by students
- Policies about functional mathematics requirements for progression to the next level of the vocational programme.

In the first section of this chapter, the effects of prior attainment on student attitudes towards taking a functional mathematics course were explored. These attitudes were interlinked with policies that determined whether students with a GCSE grade C in mathematics would be exempt from taking functional mathematics or not. The requirements of different policies fell into four main categories, as follows:

1. compulsory for all students on a particular course with no exemptions
2. compulsory for all students on a particular course who did not have a GCSE grade C
3. optional for individuals on a course (although this usually included some restrictions)
4. restricted access (meaning students would be expected to take one functional skill but the choice of skill would made by the department for the student group).

The main impact on individual students arose as a result of functional mathematics being imposed as a compulsory subject. A number of cases will now be described briefly to illustrate the range of responses and outcomes for students from the compulsory and optional policies that they encountered.

Firstly, Darren (PA1) explains his position as student in a group where there were no exemptions.

> Like at the start of the course most of us were confused on why it was relevant to this course but now I see it is relevant. (Darren, PA1)

Despite some initial doubts about the value of the course, Darren began to understand the relevance of functional mathematics and students from this group later talked about having a better understanding and increased confidence to apply mathematics into a 'real life' situation. In this case a policy that had caused an unwelcome addition to the vocational course actually became a beneficial experience.

Not all the students, however, agreed with this view as demonstrated by these comments from two students on an Electrical Installation course (CB1).

Ethan	I think it's just there to like remind you.
Tom	Refresh your memory.
Ethan	There was nothing new in it that we did that I can't remember doing at school.
Tom	I know people who've done different courses and they've got a C or above in maths and they don't have to do a functional skills course but we do.

Ethan and Tom had also been given no choice about taking functional mathematics and approached the subject with some scepticism because they had already achieved a recognised standard with their GCSE mathematics grade C. By the end of the year they had still failed to see the purpose and, from their position, the course was only useful as a revision of work that might otherwise have been forgotten.

They were also aware of a difference in policy between their department and others in the same college. There was concern about this variation in policy and a sense of injustice in being forced to take the subject when other students in the same college were exempt. This inconsistency seemed to result from the devolved responsibility for policy and suggests there were disadvantages in allowing departments to make these decisions in addition to the intended benefits of being able to relate policy to vocational needs.

Students who were given the option of taking functional mathematics also demonstrated mixed reactions, as the following example shows.

Oliver:	I was terrified because I knew I was weak at it. I couldn't do, I could not do percentages, I couldn't do ratios, I couldn't do fractions, I couldn't do formulas. I certainly hadn't a clue about algebra. I can do it all now.
Martha:	I was really angry because I thought it's over and done with. I don't have to do it again. Oh yeah you do. I was really a bit cheesed off about that.

(Later in the same discussion)

Martha:	Yeah, I'm glad I have done it though because like I said, 5 years of doing it, didn't get anywhere. About 9 months and I'm sorted.

Oliver and Martha (PA2) had the choice of taking functional mathematics or GCSE mathematics or no mathematics at all but were recommended to take a course due to their previous low attainment at GCSE. Oliver opted into functional mathematics because it was a subject he knew he needed to improve and his decision resulted in a very positive outcome. Similarly, Martha underwent a transformation in her attitude and achievement despite her initial adverse reaction to the prospect of taking a mathematics course. For both these students, opting into functional mathematics meant acting against their initial emotional reactions and but the outcome was clearly worthwhile.

Policies that made functional mathematics compulsory or optional led to varying outcomes for students and were dependent on other differences, such as their on-course experience and prior attainment. For Oliver, Martha and Darren, their initial reactions were negative but there were positive outcomes. The effect on Ethan and Tom of differences in policy requirements between departments, however, provides an example of the unintended consequences of some college policies.

Interviews and informal discussions with staff revealed that in this college every student was expected to take one functional skill but that the choice of whether this would be mathematics, English or ICT was a departmental responsibility. This was typical of the approaches in the other colleges and seemed to originate from government guidelines at the time of the research that required students to take at least one functional skill. There was some evidence in staff interviews that departments tried to select the functional skill that seemed related most closely to the demands of students' vocational specialisms but focus group discussions suggested that these choices did not always match students' perceptions of their needs. Students wanted to see policies that were fair, equitable and offered clear personal benefits. Inconsistencies, unexplained policies and a perceived lack of relevance for the individual were sources of discontent.

Furthermore, some policies placed inappropriate constraints on student opportunities. For example, English was selected as the compulsory functional skill for all Level 2 Hairdressing students in one college. Since the policy only required students to take one functional skill, this meant that students with low attainment in mathematics had no opportunity to improve their understanding of the subject during that year. The consequences of policy decisions made in response to government guidance were, therefore, sometimes counter-productive in terms of students' progress with mathematics by restricting opportunities for those who needed to improve.

The second policy with a significant impact on the student experience concerned the level of examination entry for individual students. Policies sometimes restricted students to a certain level of qualification. For example, in some cases a whole group were all entered for the same examination even though their teachers believed some students were capable of a higher level. Other policies allowed individual students to be entered at different levels but there were variations regarding how that level should be determined. Some colleges employed ‘safe’ strategies and entered students for a qualification they could easily achieve before possibly allowing them to try a higher level at a later date. Each of these policies led to some confusion amongst students about the value of the course and the qualification, as Jason’s comment illustrates.

> I think for me it’s only equivalent to what GCSEs I got so it’s kind of pointless… (Jason, CB1)

Students often made comparisons between their GCSE grade and the level of functional mathematics they were expected to achieve by the end of the year. Although some students appreciated that functional mathematics involved different skills from GCSE they were keen to achieve a qualification that signified progression rather than a replication of the level they had already achieved. For students with a low grade in GCSE mathematics, or no qualification at all, this was not a problem since any achievement was useful, but for others another certificate at the same level was insufficient proof of progress. College policies that restricted examination entries to ‘safe’ levels only served to promote a view that the course and qualification had little value.

The conflict for colleges in setting policies for examination entry was explained by some staff in their interviews. ‘Safe’ policies were sometimes justified on the basis of building the confidence of students who had previously experienced failure but college success rates were always under scrutiny and some staff believed this was the real driver for the policy. This belief was supported by the way in which one college abandoned their ‘safe’ strategy for a ‘stretch and challenge’ approach when they were anticipating an Ofsted inspection. In this policy, students had to aim for a level that showed progress from their initial assessment at the beginning of the year even though teachers’ comments suggested that some students would find it difficult to develop the application skills required for functional mathematics and achieve success even at the same nominal level as their prior attainment.

The third policy area with an effect on students was the requirement of a functional mathematics qualification for progression to the next level of vocational training in college. When David’s Public Services group (PC1) were asked what felt they had gained from their functional mathematics course they referred to this requirement.

Tina:	Another qualification. That's about it.
Aaron:	It's just a qualification to get us into next year isn't it?
Sian:	Mm.
Aaron:	Doesn't mean anything actually because…
Tina:	Not if you've already got it.
Sian:	That's the only reason why people take it isn't it?
Aaron:	Exactly. It's just a thing to get on to another course.

In this case, students who did not complete the course or take the functional mathematics examination were, theoretically, not allowed on to the next level of their vocational course. There were similar policies in all three colleges but in discussions with students it became apparent that the exact requirements were not always clear and some doubted whether the policy would be strictly implemented. The policies themselves also varied between colleges and departments. Some specified a particular level of attainment for progression, whilst others required a pass at a level determined by the teacher for each individual student and others would be allowed to progress if they attended the course and sat an examination, regardless of whether they passed it or not. There was often confusion amongst students about exactly what they were expected to achieve. These inconsistencies seemed to undermine a policy which, as some staff explained in their interviews, was actually intended to communicate the importance of functional mathematics to vocational students.

5.3 Students' perspectives on the subject of mathematics

5.3.1 Views of school and college mathematics

In the first section of this chapter the existing attitudes of students towards mathematics were discussed and how these were strongly linked to their learning experiences in school classrooms. These encounters with mathematics contributed to a view of the subject that had become well-established by the time they entered college. Students' perceptions of the subject will now be explored further through discussions in which they compared school and college mathematics.

> In this one they relate it to real life so you can understand it better. The one in school used to be from a text book and the teachers just used to make us copy out of the textbook for an hour. That's it. (Ben, CA2)

Ben had developed two views of mathematics that were very different because one belonged within an educational institution whilst the other was linked to his life outside. The mathematics he encountered in school was based on a fixed system of rules within the text book that had to be learned and followed, involving knowledge and processes that seemed remote from his life experience. In college he was learning through applications to life situations with connections to familiar experiences that aided his understanding. His comment shows some similarity to the views of other students about the frequent use of paper-based methods, repetitive tasks and working from text books in school. Mathematics was often associated with boring methods and a lack of stimulation. This was consistent with the indications from the results of the individual student activity, which showed that in school mathematics lessons many students were bored (67 out of 102 were bored 'half the time' or more) and did not often find it interesting (68 out of 102 students found it interesting 'occasionally' or 'almost never').

Another student, Connor, also noted some differences between mathematics in school and college.

> Because at school you was doing maths to get grades where you'd do certain types of maths just to get you better grades but here you do maths that's going to help you with future life and stuff that you're always going to need. (Connor, CC2)

For Connor, mathematics in school was linked to a system where the results of external assessment were highly valued and provided the primary reason for learning. Other students also expressed similar views that learning mathematics had been about acquiring the right knowledge to pass an examination and had no other purpose. Connor now found more usefulness for the functional mathematics he was learning in college because, like Ben, he saw a connection between mathematics and his personal life. He was beginning to cross the boundaries and see how his knowledge of mathematics could be applied outside a classroom rather than simply used to pass an examination. Mathematics was becoming a tool that he would actually use in his life rather a knowledge-based academic subject.

Charlie expressed the contrast as follows:

> You didn't put it into situations at school. You just learned how to do it.
> (Charlie, CC1)

In his view, mathematics in school involved becoming familiar with processes and procedures in order to 'do mathematics' but in a way that was unconnected to life outside the classroom. The emphasis on learning process skills without application to a scenario or use of context was frequently mentioned as a feature of school experience and, in many cases, was a contrast to the way functional mathematics was presented in college.

Jenna:	The maths is more like day to day problems.
Charlie:	Yeah, like that what we did last week was like putting stuff in the van, all the different weights. That was linked to a problem wasn't it?
Jenna:	A life-like situation kind of thing.

Jenna and Charlie (CC1) emphasised the practical value of functional mathematics compared to a paper-based knowledge of processes that seemed to have no obvious use for them in the world outside the classroom. Practical usefulness was valued highly by many students, particularly if they could identify an immediate application or one they could foresee in the near future. Earlier, Ryan illustrated the difference between these two types of mathematics by contrasting the practical skills of functional mathematics to the irrelevance of a particular GCSE topic, Pythagoras' theorem, when shopping in the Co-op supermarket. Several topics in GCSE mathematics, such as algebra, Pythagoras' theorem and geometry were discarded as "pointless" mathematics by students since they could see no obvious use for these in life. Applications of these particular areas were difficult to identify and the students tended to adopt a utilitarian view that focussed on direct applications to their current lives rather than embracing a broader view of the curriculum.

There were, however, clear differences in students' views of mathematics between groups, suggesting that factors within their differing classroom experiences were influential. Whilst many agreed with students such as Charlie, Jenna and Ryan, other groups saw no difference between mathematics in college and in school. In some classrooms functional mathematics was presented as a relevant set of skills that could be applied to life and students' views of mathematics began to change when they understood it could be a useful 'tool for life' rather than an academic discipline. It seems that different teaching approaches created contrasting perceptions of functional mathematics for students despite a shared curriculum.

Students' discussions about mathematics tasks also revealed some interesting assumptions, as Tammy's comment suggests.

> You would have thought they'd put more graphs or something to make it look like a maths question. (Tammy, PA1)

Tammy was uneasy with this task about planning a holiday because it lacked distinctive features that she identified with mathematics questions. Other students viewed this as a 'realistic' task because the information resembled a proper holiday brochure. For Tammy, inserting a graph would have helped create a more acceptable balance between presenting the task as a 'real life' problem and retaining the features expected in a mathematical question. Making the bridge between mathematics and 'real life' did not always seem easy for students.

Similarly, when examining a question about choosing an MP3 player, Aaron was confused.

> Well it's about an MP3 player isn't it? What's that got to do with maths? It's just a pointless question because there isn't really an answer is there? It's what you choose so it's a pointless question.
>
> (Aaron, PC1)

With this task he found it difficult to identify where any mathematical processes would be used. Comparing the given information and selecting an MP3 player did not fit his expectations of a mathematical problem. A further difficulty for Aaron in identifying this as a mathematics question was that it did not have just one right answer. The possibility of multiple 'correct' solutions seemed contrary to his expectations but was consistent with the assumptions made by other students that mathematics was a system of rules that produced one right answer. Alternative solutions suggested by students would normally be simply incorrect answers. Aaron's view of mathematics was of a system that had no relation to the choices he might make in real life. For students who held similar views of mathematics, embedding functional mathematics into 'real life' scenarios sometimes meant the mathematics was hidden and the possibility of several correct solutions was confusing. Understanding the functional approach to mathematics meant adopting a different view of the subject from that established through their experiences in school.

5.3.2 Views of mathematics in relation to students' vocational training

> I've come to college to do hairdressing not to do maths. I didn't pass it at school because I couldn't be bothered to do anything. (Eva, HB2)

For Eva, mathematics and hairdressing and were very different subjects that evoked contrasting personal responses. Hairdressing was a vocational option she had chosen to study in college whilst mathematics was a school subject she had failed and preferred to keep at a distance since it had no apparent use in relation to her goal of becoming a hairdresser. Her surprise and reluctance regarding the prospect of taking a mathematics course in college were typical student reactions, even though statements about taking functional skills alongside vocational courses were present in college brochures. Functional mathematics and vocational staff described in their interviews how this information was also provided at open evenings and induction events but suggested that students tended to ignore information that was not welcome. The need for mathematics within a vocational training course was something many students initially found difficult to understand and it was a subject they would happily avoid.

Lesson observations showed how there was often a disconnection of functional mathematics from the vocational programme in both practical arrangements and pedagogy. In the remainder of this subsection several aspects of the isolation or integration of functional mathematics into the vocational programme will be examined with particular reference to Richard and Lindsay from the case studies in the previous chapter.

Richard was a part of the vocational team and his familiarity with the Hair and Beauty department facilitated some integrated approaches although the functional mathematics sessions were taught separately. The students noticed how he related mathematics to hairdressing.

> A scenario. He's doing it into a scenario so that makes it more interesting and more fun to learn about rather than just being sat down writing on the board and working out. (Ellie, HA1)

In his interview Richard explained how he was able to construct mathematical tasks in the hairdressing context that used authentic information, sometimes integrating vocational knowledge with mathematical processes in problem-solving or linking the content to elements of the vocational programme that students were currently learning. A project about setting up a salon, for example, was designed to combine functional mathematics and English with vocational knowledge in a relevant extended task. This approach established connections between the vocational programme and functional mathematics that were meaningful for students like Leanne and Ellie who then began to appreciate the purpose of the mathematics they were learning.

Lindsey, as part of a central team, used personal applications of mathematics in preference to vocational contexts because she was unfamiliar with the area and unable to accommodate the wide range of vocational interests represented within her teaching schedule for the week. Although her teaching was effective, the additional potential for vocational integration and relevance was difficult to access from her position in a centralised staffing structure.

In the questionnaire results for functional mathematics teachers shown in Appendix 3.1 (page 286) most teachers 'agreed' or 'strongly agreed' that they had good working relationships with vocational staff (29 out of 33 responses) but only half 'agreed' or 'strongly agreed' that they worked together to develop mathematics tasks for students (17 out of 34 responses). The main reasons given for communicating were student behaviour in class, attendance and student progress, whilst functional mathematics, the vocational subject and practical arrangements were the least frequent. Collaboration to build connections through the use of vocational context or links to the vocational scheme of work did not appear to be a high priority.

Being based in the vocational department meant Richard also had a better personal knowledge of the students and awareness of practical issues than a visiting teacher, like Lindsay, who only saw the group once a week. His relationship was not only dependent on interactions in functional mathematics sessions but he was able to relate to students about aspects of their vocational programme. This was illustrated by the way in which, during his interview, two students interrupted the recording for his advice about a matter related to their vocational programme and he was able to assist. His position in the vocational team helped him develop closer relationships and an identity that was connected with the students' vocational focus.

As a visiting teacher from another site Lindsay encountered some difficulties with changes to practical arrangements. On several occasions she arrived to find her scheduled room occupied which led to delays and clearly identified her as someone who was unfamiliar with the daily working practices in the department. Practical arrangements in college often seemed to work against the efforts of teaching staff to connect mathematics to the vocational area but this was a problem also encountered by those in a dispersed structure. For example, the location of the teaching room for Richard's functional mathematics group was in an unfamiliar part of the college and students' comments suggested they were uncomfortable about being so distant from the familiar surroundings of their base in the training salon. Furthermore, as described earlier, the posters identified the room with A-level mathematics, emphasising the difficulty and remoteness of the subject from their vocational interests.

Timetabling functional mathematics away from the vocational area in a room designated for other subjects also occurred in several other cases. Of the six Hairdressing or Beauty Therapy groups in the research, four were timetabled in separate teaching blocks at a distance from the Hair and Beauty departments. In Public Services only two groups were remote from the vocational base although four of the five groups had room changes during the year and

David struggled to find a suitable room at all for his Public Services group. Room and timetable changes were common occurrences causing disruptions to functional mathematics courses. The impression given was that functional mathematics was less important than the vocational course and could be moved or cancelled whenever there were more pressing needs associated with the vocational programme.

Leanne was particularly concerned about the timetabling of functional mathematics when she started her course.

> Yeah. It annoyed me like how it was put on an extra day like of our course and having to come in an extra day but that only annoyed me at the start and then you got into the routine of coming in so it wasn't any different really. (Leanne, HA1)

Several other vocational groups had similar arrangements, whilst others tried to integrate functional skills sessions into the vocational timetable. The separation of functional mathematics from the vocational sessions in college was generally unpopular with students, creating some negative dispositions towards the classes and impressions that the lessons were an addition to the student programme rather than a core part of their studies. Practices such as these underlined the 'distance' between mathematics and the vocational course rather than making the connections that might help students appreciate the value of the subject.

Comparisons of functional mathematics and vocational sessions from the observations carried out highlighted several differences that further underlined the separation of mathematics from the vocational programme. These are briefly summarised below.

1. Vocational teachers often adopted the role of a facilitator of learning rather than an instructor. The students took more ownership of their own learning in vocational sessions and there was less reliance on instruction and direction before commencing tasks. Work was usually individual, as it was in most functional mathematics sessions, but informal discussion with peers was an accepted part of the learning process and there was less focus on teacher-led activity.

2. The structure of the vocational session was generally fairly flexible with less formality and structure than most functional mathematics lessons. The pace of working was largely determined by the individual and students could make personal decisions about how and when they tackled the tasks, within a given time frame. This rarely happened in a functional mathematics lesson.

3. The physical environment was spacious and students were free to walk around to find equipment or have discussions with their peers. Space in functional

mathematics classrooms was more limited and students were usually expected to sit in one place for the entire session.

4. The vocational sessions had a clear focus on the values associated with employment. The main rules of conduct were the professional standards, including health and safety procedures that would be expected in the workplace. Knowledge of vocational theory was integrated with practical competencies into tasks. Although sometimes taught in a classroom, these theory sessions were closely linked to the practical skills required for the workplace. In functional mathematics lessons applications in vocational contexts were used but practical activities and vocational values were less prominent.

5. Functional mathematics was always taught in a classroom and was, therefore, set apart from the practical side of the vocational programme which took place in training salons, workshops, fitness studios, sports facilities or in outdoor situations.

Positioning functional mathematics lessons within a vocational programme presented practical and pedagogical challenges. Students had expectations of learning situations based on their experience of vocational training and the values of the vocational area. The contrasts between vocational learning situations and functional mathematics classrooms emphasised isolation rather than integration but there were attempts to build a more connected view. In the following section some of the ways in which connections were constructed in lessons will be examined in more detail.

5.4 Building connections in functional mathematics lessons

Teachers in the study were all using the same functional mathematics specifications and teaching similar students in comparable environments but classroom practices showed wide variation. In this section the main case studies will be used to illustrate some of the differences in interpretations and implementation of the curriculum. This will be followed by a consideration of students' perceptions of the relevance of functional mathematics and the ways in which meaningful links were made to their lives outside the classroom.

5.4.1 Interpretations and implementation of the functional mathematics curriculum

The specifications for functional mathematics qualifications suggest several key features of a functional approach but the research indicated some variety in the interpretation and implementation of the curriculum guidance. In their own personal statements about the meaning of functional mathematics, the most frequently occurring references made by teachers were to functional mathematics involving ‘real’ or ‘everyday life’ situations, ‘applying’ or ‘using mathematics’ and ‘solving problems’. Survey responses showed that all the functional mathematics teachers in the study ‘agreed’ or ‘strongly agreed’ (38 out of 38 responses) that functional mathematics involved real life applications and problem-solving skills, that the skills were transferable and almost all ‘agreed’ or ‘strongly agreed’ that functional mathematics required reasoning and thinking skills (37 out of 38 responses). This level of agreement about these features was not consistent, however, with the range of approaches observed in lessons. The impact on classroom practices will be examined by using extracts from interviews and observations of the case study groups taught by Lindsay, David and Richard.

In her interview, Lindsay explained about her perceptions of the purpose of a functional mathematics course for students who had recently left school.

> I keep saying to my students “I’m not here to teach you, you’ve had 9 years of it, 9-11 years of it. I’m not here to reteach you. I’m here to remind you, if you’ve forgotten how to do some of the maths functions but it’s about the problem-solving aspects” and that’s what we’re changing, the culture, as much as we can. (Lindsay)

In her view, functional mathematics had a different focus from traditional mathematics and needed to be taught in a different way, by building on students’ prior learning. This reflected the views of other teachers who indicated that functional mathematics was not the same as GCSE mathematics (23 out of 28 ‘disagreed’ or ‘strongly disagreed’) nor was it the same as basic numeracy (30 out of 36 ‘disagreed’ or ‘strongly disagreed’).

Lindsay’s distinction between school and college mathematics as belonging to different cultures made it clear she did not expect to be using the same approaches as a mathematics teacher in school. She defined functional mathematics as “The application of maths skills in everyday life situations (at college or at home) to solve everyday problems (small or large)” and her emphasis in lessons was on creating connections to ‘real life’ through authentic descriptions of scenarios that related to students’ personal experiences and interests. The importance of using ‘real life’ scenarios was shared by other teachers since all the functional mathematics teachers in the survey ‘agreed’ or ‘strongly agreed’ that functional mathematics involved real life applications (38 out of 38 responses) and lesson observations showed how many teachers focussed on applications of mathematics. The way in which ‘realistic’ scenarios were used though did vary. Lindsay explained her approach as follows.

> As much as anything, depending on the topic, as practical as I can make it. The way I do it is I do it by topic. In my mind, every week has got a topic in the background so I might be thinking it's going to be ratio this week and added on to that I'll try to think well what's relevant in life with ratio so it might be cooking. So we'll do a lesson where - they are not cooking practically but doing an idea of a recipe, and doing something or we might be doing exchange rates. Certainly if I'm teaching Travel and Tourism, we'll do exchange rates because that's to do with ratio. So I start with a topic and then build on that to make it relevant to them and interesting to them and get everyone involved.
> (Lindsay)

Although she referred to her methods as being a practical approach using different contexts, she acknowledged that the classroom activity was not really the same as actually carrying out a practical task in a real situation. In practice, these activities were often still basically a mathematical exercise wrapped in a context rather than a 'real' practical task in which mathematics was embedded. Some teachers, however, did include some alternative types of practical activity, such as Chris (CA2) who involved his construction students in some practical measuring tasks and Elliott (CC1/CC2), whose students built a scale model of a proposed new housing estate before preparing plans and calculating costs for supplying the essential amenities. Rarely, however, were mathematical tasks performed in a 'real' practical situation during functional mathematics sessions, although practical uses of mathematics were observed within vocational sessions.

Lindsay explained how she took mathematical topics one at a time rather than using a more connected approach across the curriculum. This was common practice amongst other teachers, although some did adopt a more task-focussed approach at times. For example, Richard took the view that functional mathematics was "A lifestyle way of using mathematics". He described his teaching as taking a 'common sense' approach to functional mathematics by embedding mathematical processes into scenarios.

> I've found that having a task like we are now designing a salon, what size do you need? What you've just done is we've now just worked out the area. The way we would show that as a maths calculation is this way. (Richard)

Richard used this extended task as a basis for teaching several topics in his scheme of work. He also used problems that might naturally arise in the hairdressing salon practices, such as planning an appointment schedule, which required students to use their vocational knowledge of times needed for different treatments in conjunction with mathematics to complete the task. In this way a more integrated and holistic view of learning mathematics was presented that also connected mathematics to students' vocational interests.

In contrast, David stated that functional mathematics was "Using mathematics as skills for life and applying these skills in real (day to day) life" but used tasks with out-dated details and a style that resembled the formal mathematics problems students associated with school. These did not resemble realistic situations or authentic applications of mathematics and therefore students were unable to make meaningful connections to their vocational programme or personal lives.

These three cases also suggest different views of problem-solving and the type of problem considered appropriate by teachers for use in functional mathematics classrooms.

> So, with the moment, the culture I'm trying to instil in the students at the beginning of the year is that functional skills is not about a right or wrong answer, it's about solving a problem. I make examples of, if you needed to get to London tomorrow at 11 o'clock in the morning, one person might take the bus, one person might drive and one person might get the train. So long as you're all there by the same time, it doesn't matter how you got there, how much it costs so long as you can justify it. (Lindsay)

Lindsay explained in her interview that a functional approach involved problems with multiple correct solutions rather than just one right answer but observations of her lessons showed how opportunities for more open questions were sometimes missed. There was a contradiction between her stated beliefs and working practices. As discussed earlier Lindsay's personal love of the "neatness" of mathematics and the satisfaction of getting the 'right' answer seemed to influence her classroom practices despite her clear statement about the curriculum.

David believed problem-solving was about analysing situations and applying logic. He explained how he expected the students to learn "how to apply different rules of mathematics in solving a problem" and that "numbers make an image about the real problem in life." His background in engineering seemed to influence his interpretation and lead to a more academic view of deriving mathematical models rather than solving practical problems. Richard, however, took a very practical approach to problem-solving by using workplace situations and even deliberately included errors in the information, since he believed this would more closely resemble a realistic problem at work. These scenarios were used to show how problems occurred in the workplace with solutions that happened to involve mathematics in conjunction with vocational knowledge. In contrast, observations of

David's lessons showed more emphasis on the mathematical processes and his attempts to incorporate 'real life' situations were only in the form of convenient contexts superficially wrapped around a mathematical problem.

One of the common teaching approaches used in observations and appreciated by students concerned the range of alternative methods and individual choices made available in functional mathematics classrooms. Nina, a Beauty Therapy student, expressed her view as follows:

> Keith actually gives you ways of teaching you how to do some things better. Like if you've got a way of doing something he'll teach you a way to do it easier. (Nina, HC2)

Students often talked about being taught different ways of tackling mathematical calculations compared to school and discovering alternative methods that made sense to them. Teachers, like Keith, often provided alternative methods to suit the individual, rather than expecting the entire group to work in the same way. This individualised approach was made easier because class sizes were usually small compared to school. Lesson observations showed how some teachers spent a considerable amount of time with individuals, persisting with alternative explanations and methods, which students like Marion and Yasmin (PA2) clearly appreciated.

> Marion: That is true. It does depend on the teacher but we're lucky to have Edwin as our teacher for maths.
> Yasmin: Because he actually cares.
> *Diane*: Is it a positive experience now then?
> Yasmin: Some of the stuff Edwin is teaching me now I should have learned in school and I sat there thinking "I've never seen it in school" and should have learnt it in school but I've never seen it in school. But the way Edwin like teaches it, like explains, teaches stuff and explains it in a more simple way. Some will … go back a long way to explain it and we still don't get it but Edwin, he explains it and I get it straight away.

Clear explanations were valued by students and contributed to their enjoyment of lessons but this was not the only factor that evoked a positive response. The feeling that their teacher actually cared about their progress, had an enthusiasm for teaching the subject and a desire for them to learn also seemed important.

Edwin's approach was to spend time with each individual and persist patiently until they understood, whilst Lindsay's students described their lessons as a "roller-coaster" experience in which variety and interest were key features. David's students expressed boredom with lessons that involved a fairly predictable routine of a teacher explanation to the group about a topic, followed by individual work on questions. Content and pedagogy were clearly important but these student responses indicated there was also a strong personal influence from their teacher. The personal interactions of students with Edwin, Keith and Lindsay seemed to have a positive effect on their attitudes and in the following subsection these relationships between students and teachers will be explored further.

5.4.2 Teacher-student relationships and the influence on learning

Most functional mathematics teachers explained in their interviews that motivating and engaging students was important, recognising that disaffection and disinterest in mathematics presented barriers to learning and needed to be overcome. Changing these attitudes was seen by most teachers as a difficult problem with no easy solution but some used approaches that seemed particularly successful.

> I'm open to their negativity and I make a point of saying 'right, hands up' in the first lesson 'who hated maths and who's got that negative attitude towards maths?' (Lindsay)

Lindsay's direct approach to the problem indicated that dealing with negative student attitudes was a priority but this also laid the foundations for building a different relationship from those students had experienced with their mathematics teachers in school. She explained how these relationships were important in her teaching approach and contributed to creating a different classroom culture.

> I'm not that formal a teacher I suppose and I don't think you can be too formal in functional skills. Well, that's certainly my view. I'm quite – I've certainly got the boundary – I'm not their mate, but I think I have a bit of a laugh and a joke with them and try and make that lesson relaxing for them, whilst still teaching. You know, I might give them a little time. For instance, on a Monday morning I have the Sports students who are all interested in football and all they want to talk about is what the scores were on Saturday of course, so I'll give them a little bit of banter and then focus back in. (Lindsay)

Lindsay believed she was taking a fairly informal position but still with some authority and 'distance' between herself and the students. This freedom to discuss and to sometimes deviate from mathematics was evident in observed lessons and contributed to a fairly relaxed environment but within a planned lesson structure. Similarly, informality and flexibility were key features of the classroom culture in Richard's lessons and he also used informal discussion to build relationships. In contrast, David retained a formal approach in the classroom and his relationships with students were distant.

The type of classroom culture created seemed to have a significant effect on student engagement with learning and was dependent on the nature of the teacher-student relationships. Positive relationships seemed to be a particular feature of groups in which student attitudes to mathematics improved (see Appendix 4.3?).

For example, Jess, Nina and Isla (HC2) had approached college with negative attitudes and poor attainment in mathematics but they explained in their final focus group how their attitudes had completely changed.

Diane:	So it's been a positive experience then?
Jess:	Yeah. Keith is a legend.
Nina:	Yeah. He does make the lessons fun.
Isla:	Yeah.

They attributed the credit for their transformation entirely to their teacher, Keith, with whom they had developed a strong relationship and explained that their only regret about passing their course was that they would not see him again for any more lessons. This was a significant transformation from their earlier negative emotional responses to the prospect of taking a functional mathematics course.

Similarly, Lindsay's students identified earlier how she was a key factor in the way they had come to view functional mathematics and this was typical of student groups who developed positive attitudes towards functional mathematics. Lindsay's students appreciated the relationship she had formed with the group but also highlighted how her teaching and learning methods contributed to their enjoyment of lessons. In the colleges within the study, these methods were usually chosen by the individual teacher and not prescribed by college or departmental schemes. Individual teachers had a considerable level of autonomy and, therefore, a strong influence over the learning process through their personal decisions about methods and materials.

The students also valued personal qualities that they felt had an impact on their learning experience such as Lindsay's positive attitude towards teaching the subject.

> Looking back on it, I think you're passionate for whatever you teach. You have to be and I was passionate about Key Skills but looking back, functional is just phenomenally better and more relevant to students.
>
> (Lindsay)

Lindsay's belief in the value and relevance of the subject for students affected her behaviour in lessons and her enthusiasm seemed to be absorbed by students. Ryan explained in the focus group how he personally responded better to teachers with a positive attitude because this communicated to him that their recommendations about the subject were genuine. In this case, Lindsay's enthusiastic approach in lessons matched her recommendation that functional mathematics was relevant and this encouraged Ryan to engage with the lessons.

Most functional mathematics teachers 'agreed' or 'strongly agreed' that functional mathematics would help students with their vocational course (31 out of 37 responses), that they would use the skills in their personal lives in the future (35 out of 37 responses) and that skills would be useful in the workplace (36 out of 36 responses). There was general agreement that this was a useful and relevant subject for students but teachers' attitudes in class did not always match their statements. For example, one group of Hairdressing students (HB2) were very dissatisfied with their functional mathematics lessons and felt this was partly due to the teacher becoming "stressed" when they did not understand his explanations. Another group (HA2) commented that their enjoyment of lessons was dependent on whether the teacher was in a "happy" mood on any particular day. This variability in teacher attitude led to an uncertain relationship and mixed feelings about their learning experience. Maintaining a positive attitude as a teacher in class seemed to be a significant factor in developing relationships of trust and integrity.

Lindsay's students also commented on how they found her "approachable". In lesson observations it was clear that they felt at ease with Lindsay, which meant they were comfortable about asking for further explanations or seeking extra help. The open dialogue between teacher and students seemed to create a supportive classroom culture in which students readily asked questions and discussed their difficulties. In her interview, Lindsay talked about the importance of understanding her students and establishing relationships.

> It's difficult when I've got a class where I'm not interested in their topic. I've got, for instance, a Games Design class this year and I have no idea how to do computing. I have no interest whatsoever, so I struggle to relate to them, their personalities somehow, whereas the Sports students, when I teach them I think 'well I've got an interest in Sport and quite interested in fitness' so I can really relate to what they're talking about and what their passions are. So I think that's important, really important, in functional skills. (Lindsay)

Lindsay was keen to develop strong relationships with students so she could relate to them and understand their interests. Her lack of knowledge of some vocational areas was a concern, since she did not feel she could identify with the students or understand their priorities. Her observed lessons included frequent discussion around the scenarios used in mathematical tasks but also included informal conversations with individuals or small groups about matters unrelated to the tasks.

> I try and get to know them, obviously. In the first lesson I try and get to know what their hobbies are and try and tap into some of those, if possible. (Lindsay)

Lindsay wanted to listen to students and find out what interested or motivated them so she could adapt her teaching and make it relate to their lives and values. Conversations with students were not just about mathematics but were a means of discovering their interests so that she could use these as part of her strategy for engaging students in lessons.

> I'll ask them direct questions and try and remember what they're interested in and ask what maths did you have to do for that? Suddenly it's 'oh gosh, I'm being included here'. (Lindsay)

Lindsay used her knowledge of students and their interests to select suitable contexts for tasks that emphasised the applications of mathematics relevant to their lives. In addition, she recalled information about their interests to generate conversations about the uses of mathematics within these areas. This dual strategy to engage them in lessons utilised questioning techniques and dialogue to link mathematics to their interests.

A similar strategy was used by other teachers, such as Richard.

> The biggest thing I have in lessons is that, give me any question, you can think you're trying to distract me but I will turn that into a maths question somewhere along the line. It doesn't matter what it is. If you say you're going out and you're drinking 10 pints, I will turn it into how many calories are in a pint, so how many calories are there? So I will make it relevant to – now you're a female, you're drinking this, you've drunk this many units of alcohol, it's got this amount of fat in it, how much exercise do you have to do to get rid of that Friday night going out, to get into that nice size 10 dress you had on? (Richard)

Richard used informal conversations to make connections between mathematics in the classroom and the activities that were part of student lives. His flexible approach allowed space for deviation from planned mathematical activity to pursue these opportunities as they arose. It was a priority to link mathematics to student interests rather than present subject content that was remote from their experience of life. Like Lindsay, he used naturally-occurring opportunities in conjunction with questioning techniques to build connections. His informal relationship with the students enabled him to participate in conversations about their lifestyles that he could use to advantage as contexts for tasks, whilst also demonstrating an interest in them as individuals.

Students' relationships with teachers had an influence over whether they responded positively to learning functional mathematics, as Leanne and Ellie (HA1) explained.

Leanne	It sounds weird but you see him more as a friend.
Ellie	You see him more as a friend than a teacher.
Leanne	I like how he is with us. I don't think I'd get – I don't think if I had like a different teacher I don't think I would have done this well. Without Richard I don't think I would have got through.

Leanne and Ellie explained earlier how wanted to learn because of the relationship that was established between them and their teacher. They valued his relaxed approach but appreciated the balance of informality with control. His humour contributed to a manner that made him approachable and this was a characteristic mentioned by other groups as one of the reasons they could 'get on' with teachers. Leanne seemed surprised by her own conclusion that she saw Richard as a friend but the relationship was clearly an effective means of engaging these students in learning. Like the students taught by Lindsay, Keith and Edwin, they attributed their success with functional mathematics to their teacher and the teacher-student relationships in these cases clearly had a positive influence on the student learning experience.

5.3.3 Crossing the boundaries between classroom mathematics and vocational practices

All the functional mathematics teachers in the study stated their belief that functional mathematics was the mathematics needed for real life (38 out of 38 responses) and most believed it was the mathematics needed for the workplace (35 out of 38 responses). Tasks in different contexts were widely used in lessons as a means of connecting functional mathematics to student experiences outside the classroom, although with varying degrees of effectiveness in terms of stimulating interest and engagement. In this section, students' perceptions of the relevance of contextualised tasks will be explored using extracts from student focus group discussions about a particular task in a hairdressing context that can be found in Appendix 1.9 (page 277). Although this was only one of a set of ten tasks used with the focus groups, the themes represent those evident across the whole range of tasks and discussions.

The hair-colouring task

The task was set in the context of mixing dyes for hair colouring and involved calculating the amount of each dye needed to produce the correct shade and depth of colour for different clients.

The hairdressing students from Richard's group (HA1) were critical of this task because of the terminology and the details of the scenario that they felt were not authentic. In their salon they used pumps (dispensers) rather than tubes. In a later discussion with a hairdresser it became clear that tubes of dye were the most common form of packaging used in the industry but these students were not aware of this and made a judgement that the task was irrelevant on the basis of their limited experience.

This group also concluded that calculating the ratios required for this task was irrelevant because they only used one-to-one ratios in the salon. During an interview with a vocational tutor it became apparent that students would be expected, eventually, to use a whole series of ratios but at this stage in their training they were unaware of this need. Understanding the relevance of mathematics to their vocational area was constrained by their current personal experience and limited knowledge of work practices.

When a second group of hairdressers (HA2) were asked about the same task they all agreed that it appeared to be relevant and would help them with hairdressing because it was about mixing colours and this was part of hairdressing work. This judgement was made without considering the exact ratios needed in hairdressing but on the basis that the terminology and the details of the scenario reflected familiar working practices.

The opinions of a third group of students (HC1) showed more agreement with the first group. They picked out the words 'brown rinse' as an example of terminology that did not belong in a salon. In later discussion with a hairdressing tutor, it was confirmed that this was an outdated term and that most hairdressers referred to this depth of colour as 'quasi' rather than a 'rinse'. Incorrect terminology led these students to a conclusion that the task was not realistic because you would never carry out a 'brown rinse' in a salon. This inaccuracy in the details of the scenario was responsible for a rejection of the task as mathematics that was unrelated to their hairdressing training or careers.

These groups of students made connections to the task at different levels. Some connected at a superficial level by identifying key words that had meaning for them in their vocational training or personal lives, whilst others considered the complete task and compared this to working practices within their experience. In either way, students either accepted the task or rejected it as irrelevant on the basis of a comparison to their current knowledge and experience of the industry. Across the full range of tasks and focus group discussions students often seemed to make judgements by selecting key words from the description of the scenario or particular sentences, whilst only a few considered the task as a whole.

A second influence on their decisions was the immediacy of usefulness they perceived for the skills they would gain from the task. Even though this task was in a hairdressing context, the students who did not expect to use complex ratios in mixing their hair dyes judged the task as irrelevant since it had no apparent practical use. Those who did identify a direct use for the task in their current situation took the opposite view. Discussions about other tasks with students indicated that when the context could be connected to an immediate practical use then the task was often judged as relevant, whilst those linked to an expected use in the distant future were considered as having little relevance.

Thirdly, the tasks generated different levels of interest depending on the type of context and whether the connections to their lives stimulated a positive or negative emotional response. Some topics were interesting to students because they were linked to a personal interest or goal outside college but the depth of their emotional connection or affiliation to the context contributed to their perception of the relevance of the actual task. For example, contexts that related to their specific vocational speciality, such as plumbing, seemed to generate strong affective responses but those that only linked to their general vocational area, such as construction, seemed less relevant.

These three factors could be considered as the three dimensions of a conceptual framework for understanding students' perceptions of the relevance of contexts:

- the level of connection (word, sentence or task level)
- the immediacy of usefulness
- the depth of interest or affiliation.

The connections, however, were often fragile and apparent contradictions between the scenario and personal experience quickly severed the links. As the examples show, there was sensitivity to details of scenarios that resulted in tasks being rejected at word level as irrelevant simply on the basis of inaccurate terminology. In some cases the discrepancy was the result of inexperience but there was still a negative effect on students' judgements about the authenticity of the scenarios and therefore the relevance of the task.

The students explained in their discussions how contexts that were considered relevant would encourage them to attempt the task. In this way the context of a problem could be a strong motivator to engage with learning and seemed more important to students than the actual mathematical content. Using relevant contexts was a key feature of some lessons that seemed to contribute to improved attitudes and engagement but the theme of relevance cuts across several aspects of the student experience. Although some of these have already been discussed, this is an important thread and, in the following subsection, some of the ways in which students came to understand the relevance of functional mathematics will be brought together.

5.3.4 The relevance of functional mathematics to students

There are two main aspects to be discussed in this subsection and these concern the relevance of the skills students were learning and the relevance of the qualification. Using extracts from the main case studies, the relationship of the skills to students' lives will first be considered.

Students like Ryan became convinced of the relevance of functional mathematics because they began to understand some of the applications of mathematics to their lives but others were less convinced of the practical value of mathematics, as this conversation about using mathematics in the fire service suggests.

Tina:	You have to calculate how long it is before you get to the fire. How far the fire is gonna stretch, measurements and everything.
Sian:	How much water you need to put on it to put it out.
Aaron:	You're not going to really think about that when you're actually in the situation.
Tina:	Yes.
Aaron:	No you're not. Common sense. You can calculate…
Diane:	You don't need to shout.
Tina:	But you need maths to have the common sense to calculate!
Sian:	You're telling me that if you never did maths and went out on a job and you were like trying to tell your boss down the little thingy, the tannoy thing, that they're on their way and you're like… yeah, oh you don't know how many metres up the fire is, you don't know how many metres they have to go?

Aaron (PC1) made his dislike of learning mathematics clear in the focus group. His dismissal of functional mathematics as an unnecessary subject may have been linked to his disaffection but practical examples of applications such as those suggested by Sian and Tina were often unconvincing. Students with a dislike of mathematics needed strong evidence of meaningful practical relevance.

Other students also adopted Aaron's position that basic mathematical applications were just 'common sense'. In some cases mathematical processes seemed to be hidden in vocational practices and were not visible to students as mathematics but in others they felt that workplace tasks could be carried out without learning any more than the basic mathematics they already knew.

As seen in their perceptions of contextualised tasks, the limitations of students' current experience could also restrict their understanding of the ways in which they might use mathematics in the future. This was a common difficulty in student attempts to understand the relevance of mathematical skills to the workplace, due to their limited vocational experience at this stage in their training, that placed constraints on the contexts with which students would readily make connections.

Other students, such as George and Abigail (PB2), were able to identify applications of functional mathematics and valued the skills.

> George: I think the problem with GCSE maths is it's very … you're not going to use most of it because it doesn't teach you real skills. It teaches you how to do it but not when you'd do it. Whereas functional you're actually learning, like the car thing, you're learning like relevant things that you're going to be able to put into practice in life.
>
> Abigail: All I remember about GCSE is the hypotenuse of a triangle. What's that useful for?

The practical usefulness of functional mathematics was a strong reason why some students believed their learning experience in college was more relevant to their lives than their GCSE course. They valued the actual application skills but the relevance and status of the qualification itself were often contested.

Views of the qualification were often linked to perceptions of how it might facilitate progress towards individual and personal goals. Most students needed to pass a functional mathematics examination to progress to the next level in college but doubts about the policies and processes seemed to weaken the motivating effects of this reason for achievement. For some students, such as those intending to enter the armed services, the qualification might be required for entry to their chosen career but this aspect of relevance only seemed to become a strong theme in focus group discussions when students were close to making applications to the services, such as those on a Level 3 course (PB1).

The relevance of the qualification as evidence of mathematical competence was disputed. This discussion between Lee and Ryan (PA1) indicates the problem that some students encountered.

> Lee: It's more useful than GCSE. It's not more useful CV-wise, like qualification-wise.
> Ryan: Yeah, GCSE looks better but…
> Lee: But when you think about it functional skills is more than GCSE.
> Ryan: Functional skills will show more than GCSE.

There were tensions for Lee and Ryan between their appreciation of the usefulness of functional mathematics skills and the widely-recognised exchange value of a GCSE mathematics qualification in society. Although they believed that the skills they had learned in functional mathematics lessons had more practical value and personal relevance, GCSE mathematics represented a well-known standard and they were uncertain of the status of a functional mathematics qualification outside college.

Other students had a similar view of the usefulness of the skills but had different reasons that influenced their perception of the qualification.

> You see I got an E when I did my GCSEs so for me it's going to be useful because I've actually got something worth it now. (George, PB2)

George had a lower grade in GCSE mathematics than Ryan and gaining a functional mathematics qualification added value to his existing set of qualifications. In his situation, a functional mathematics qualification was relevant because it clearly provided evidence of improvement. The relevance of the qualification to the individual was often dependent on whether there was a difference in levels between their prior attainment and functional mathematics achievement. For Keira (HA1), who had already achieved a grade D in GCSE mathematics, achieving a Level 1 functional mathematics qualification, was not perceived as representing any progress with mathematics and the qualification was viewed as unnecessary. Students wanted to see an improvement in level and did not always appreciate that different skills were required for these qualifications. College policies that affected the level of examination entry for functional mathematics students had a significant impact, therefore, on students' perceptions of the relevance of the qualification.

At this point the comments made by Rhiannon and Zara (HA1) are worth revisiting.

Diane:	What does that qualification mean to you two?
Rhiannon:	A lot. Because I didn't do my exams at school so just came here and got a grade here … it's better than having nothing.
Zara:	Well I suppose it does mean summat because I never went to school and now I suppose I've got qualifications in maths.

Since neither Rhiannon nor Zara had an existing qualification in mathematics, a functional mathematics qualification might be assumed to have some value but, whilst Rhiannon spoke enthusiastically about her achievement, Zara was reluctant to admit that it may be useful. Other factors were influencing their attitudes and having a bearing on their conclusions about the qualification. Zara suggested that if she could pass then the qualification had little worth. Her low level of confidence and a belief that she still did not understand the subject seemed to lead to a devaluation of the qualification in her perception.

The relevance of a functional mathematics qualification to individual students seemed to be dependent on their existing attainment, their perceptions of the subject and the status of the qualification in society. Although also influenced by certain college policies, there were still individual affective factors such as a lack of confidence, strong disaffection or low self-efficacy that could have an effect on the perceived value and relevance of the qualification for the individual. This affective dimension influenced student decisions regarding the relevance of functional mathematics and showed some similarity to the effects of interest or affiliation in their responses to contextualised tasks. It seemed that emotional connections to personal goals strengthened their perceptions of relevance but persistent negative affective responses to the subject worked against possible reasons why individual students might find the skills or qualification relevant. This interaction of reason and emotion in these decisions was a further example of a recurring theme in the study regarding the importance of both cognitive and affective functions for these students in their learning experience.

5.4 Summary of key themes for discussion

The themes explored in this chapter and the features of the three case studies from the preceding chapter provide the data analysis from which the research questions will be addressed. Several interlinked themes have been highlighted that show how students' responses to functional mathematics were affected by emotional and social factors associated with their prior experiences of learning mathematics and by their transition into a contrasting college culture.

Attitudes and emotions, often linked to prior experiences of failure and disaffection with mathematics, affected students' initial responses to functional mathematics in college. Low levels of self-efficacy were common and some students replicated patterns of avoidance behaviour established in school rather than attempting to re-engage with the subject. Individual levels of prior attainment contributed to student perceptions of whether they needed to improve their knowledge and skills and, in conjunction with college policies, affected how they viewed the opportunity to take a functional mathematics course. For students in some groups, however, attitudes to mathematics became more positive in the college environment whilst others remained unchanged.

In the transition to college there were discontinuities in the learning situation, the organisational culture, the teaching approaches and the curriculum that led to the adoption of new values with an adult and work-related focus. The relative freedom, increases in responsibility, greater personal agency and contrasting social structures in classrooms were all features of college that were welcomed by students despite the social adjustments necessary. Within the college culture, the placing of functional mathematics alongside the vocational programme often resulted in tensions and a lack of coherence for students, underlining the divisions between a subject viewed as an academic discipline and education with a work-related purpose.

For some student groups, these divisions were minimised by functional mathematics teachers who presented an alternative view of mathematics as a useful 'tool for life'. This new image of mathematics was based on the functional curriculum but also required teaching approaches that highlighted meaningful applications of mathematics for students, making contextual connections to their vocational or personal interests. In classes where this alternative view of mathematics was promoted then students often discovered a purpose and relevance for the subject, leading to greater engagement and gains in understanding. In addition, some functional mathematics teachers created a more coherent experience for students through the adoption of classrooms cultures, social structures and approaches to learning that were more consistent with vocational practices than traditional, formal mathematics lessons.

Student experiences of learning mathematics were, therefore, framed by college policies and affected by prior encounters with the subject but classroom practices were highly influential in determining whether existing attitudes and levels of understanding improved or remained unchanged. Within functional mathematics classes, teaching approaches varied but socio-cultural aspects were important and coherence with vocational values was helpful to students. In contrast, it was the differences between the curriculum, classroom culture and teaching approaches in college compared to those associated with school that facilitated opportunities for positive changes in student learning.

The discontinuity of these aspects of the student experience in the transition to college seemed to have a positive effect whilst dissonance with the students' experience of vocational learning within college was a problem. The concepts of harmony and dissonance, continuity and disconnection permeate through the main themes from this analysis. In following chapter these themes will discussed further in relation to the relevant literature and the research questions before reaching the conclusions for the study.

Chapter 6: Discussion

In this chapter, findings from the analysis will be explored further in relation to the main research question and the sub-questions:

What factors influence the experience of vocational students with functional mathematics?

- What effects do college policies, systems and organisational cultures have on the student experience?
- What influence does the prior experience and background of students have on their attitude to functional mathematics?
- What approaches to teaching functional mathematics are being used and what effect do they have on student learning?
- In what ways is functional mathematics relevant to students on vocational programmes?

Although the research findings could be presented by addressing each question separately, there are two interlinking themes that emerge as significant threads throughout the analysis. In order to explore the relationships between these and the research findings in sufficient detail, the two themes, outlined briefly below, will be introduced and used as a structure for the discussion. The research questions will be addressed through the themed discussion before finally returning to each question in turn to summarise the main findings.

1. The transition from school to vocational education

For the students in this study the transition from school to Further Education was associated with *multiple and abrupt changes* in curriculum, culture, social structures and physical surroundings. The move into vocational education was accompanied by a period of *social adjustment and changing values* but these were viewed positively by students, due to a consistency with broader changes in their *transition to adulthood*.

In functional mathematics lessons, some groups encountered a different curriculum, contrasting teaching approaches and a new classroom culture that enabled them to construct a *different image of mathematics* and adopt a *new identity as a learner of functional mathematics*. The construction of these new images and identities was highly dependent on the teaching approaches and materials used by functional mathematics teachers but there was significant evidence of positive changes in student attitudes, engagement and understanding in some classes. These changes occurred when there were distinct differences between their experiences of mathematics in school and college, indicating that the *discontinuity* was a significant factor affecting the attitudes and re-engagement of students with mathematics.

2. Bridging the academic-vocational divide at multiple levels

The transition from school to college was also accompanied by a change from an academic environment to a vocationally-orientated learning experience. As students adapted to the dominant vocational culture in Further Education, changes in their values and expectations reflected a *reversal of priorities* as the vocational became their main focus.

Concerns about bridging the academic-vocational divide at a macro-level have frequently appeared in the literature, involving considerations of the problem in terms of the curriculum, qualifications, policies, social class divisions and stratification of knowledge within the education system in England. In this study the *division was visible at multiple levels* within the college, often creating tension between the student experience of functional mathematics and the vocational area.

Adding mathematics into the students' vocational programme reintroduced an academic-vocational tension at course level but divided priorities were also evident in the structures and policies of the college as well as aspects of classroom experience. Dispersed or centralised staffing structures prioritised benefits to either the academic mathematics staff or to the vocational department whilst mathematics tasks in vocational context were subject to students' interpretations from a vocational perspective. Students seemed to experience greater harmony when there was *a multi-level approach to embedding functional mathematics*, in which meaningful connections were made between mathematics and their vocationally-orientated values with respect to the college structures, internal policies, the curriculum and the occupational culture. Contrasts between harmony and dissonance, continuity and discontinuity in the student experience had significant effects on their attitudes and engagement with functional mathematics in college and these will be explored through the following sections.

6.1 The transition from school to vocational education in a Further Education college

6.1.1 Changes for students in the transition from school to college

In this subsection, student descriptions of their experiences in school and college will be examined to show how the discontinuity and contrasts they identified were viewed positively, despite a need to adjust and adopt new values. Their general perspectives on college and school will be examined as well as the impact on their attitudes towards learning functional mathematics.

The analysis of student attitudes and opinions of school and college shows that students in the study were aware of multiple changes in their transition from school to college, highlighting in particular the increased freedom, less restriction and greater independence. These features of college culture were also accompanied by a greater level of personal responsibility but both the freedoms and responsibilities were viewed positively by students. These findings are similar to those reported by Rudd and Evans (1998) in their study of post-16 students in Further Education who identified that students experienced greater levels of responsibility in college but valued the opportunity to make their own decisions and exercise greater independence.

In Chapter 2, the transition from school to college was placed in the context of the broader transition to adulthood. It is noticeable that students demonstrated a particular awareness and sensitivity to changes in values associated with this broader transition to adulthood, such as accepting personal responsibilities and making independent decisions (Arnett, 1997; Greene et al., 1992). Increased independence and freedom seemed to be linked to ‘being treated as an adult’ from a student perspective. In a fragmented pathway to delayed adulthood these may seem more achievable characteristics of adult status than traditional events (Arnett, 2000) and therefore their dominance in the research is not surprising. The strong positive connection by students to values associated with adult life and employment supports the view that they were “beginning to experience the rights and responsibilities of adulthood” (Rudd & Evans, 1998, p.58) and indicates that these were important goals affecting their current perspectives.

Student perceptions of having more independence and personal responsibility in college suggest that the social structures in the organisation were less restraining and that students were aware of greater personal agency, a characteristic often attributed to an increasing individualization within society (Beck, 1992; Giddens, 1991). Most students in the study believed that they had exercised personal choice in opting for a particular vocational course in college, although their GCSE grade profile did restrict the options available to them and some made constrained choices under parental pressure to continue in education. Students' perceptions, however, were that they had been free to make personal choices, despite evidence of external constraints, showing some consistency with a view of structure and agency as dual constructs affecting student pathways to adult life (Karen Evans & Furlong, 2013) in a 'structured individualization' (Karen Evans, 2002; K. Roberts, 1997; Rudd & Evans, 1998) where agency is subject to boundaries (Karen Evans, 2002; Karen Evans et al., 2012). Although seen as a general feature of their responses to the transition from school to college, this is also important to consider in relation to functional mathematics. In this respect, many students were aware of the restrictions of college policies that required them to take the subject and perceived themselves as having little personal agency, thereby contrasting sharply with the new freedoms they were enjoying. This led to some resentment and negative attitudes towards taking a functional mathematics course, which need to be considered in the light of existing attitudes towards the subject of mathematics.

There was evidence in the study of multiple effects on student attitudes towards functional mathematics due to their previous experience in schools. In the context of a general educational experience that was often associated with a lack of enjoyment, inadequate academic performance and marginalisation, many students approached college with negative attitudes towards mathematics. Their perceptions of mathematics from school showed similarities to those featured in other research studies, such as mathematics being a difficult, uninteresting subject (Brown, Brown, & Bibby, 2008; City & Guilds, 2012) and irrelevant to their lives (J. Evans, 2000; Onion, 2004). Disaffection with mathematics was common and, although this was sometimes expressed as a quiet disinterest (Nardi & Steward, 2003), many students displayed strong emotional responses to the subject. Negative characteristics evidenced in other studies such as anxiety (Buxton, 1981; Zan et al., 2006), low self-efficacy (Pajares & Graham, 1999) and a lack of confidence (Brown et al., 2008) were frequently demonstrated in students' reactions to learning mathematics.

These affective responses were based on their involvement in learning situations that had evoked negative emotions in the past but the legacy remained as they entered college. Although the social spaces of learning mathematics in school and college were distinct in a physical sense and across time, there were links between them for students. Emotional responses, in particular, were not constrained by the boundaries of space and time but reappeared once students were faced with the prospect of learning mathematics in college. In some student groups, attitudes in college then remained unchanged and associated patterns of behaviour from school, such as avoidance or passive compliance, were replicated in their functional mathematics lessons but there was evidence of improvement in certain attitudes across the case studies (see Appendix 3.3, page 285) and significant positive changes in some student groups.

Prior attainment was also a sensitive issue for students in the study and often shaped their attitudes. Other studies have examined the link between attitude and achievement (Ma & Kishor, 1997) but, for these students, a key feature was the association of low-attainment with perceptions of being neglected or having a lack of agency in school mathematics classrooms. These experiences often seemed to result in low self-efficacy and disconnection from the subject and indicate some consistency with other studies that suggests the curriculum for low-attaining students in school is often remedial and boring, resulting in "largely negative forms of mathematics identity" (Hodgen & Marks, 2009, p.13).

Students with higher-attainment, of a GCSE grade C or above, were sometimes more positive about mathematics but still had little desire to continue with the subject. In this respect, their attitudes echoed those of students in other studies who were high-achieving but had no interest in continuing with mathematics (Brown et al., 2008). Students also made comparisons to each other on the basis of their previous GCSE grade, in a similar manner to children who identified themselves by their ability group and ranked themselves by comparison to each other (Hodgen & Marks, 2009). For the students in the research there were signs that their ability level was linked to a form of individual identity and that this had an effect on behaviour (Brown et al., 2008) as they entered college.

The general transition to college for the students in the study was not a smooth process and they were aware of a sudden change into a different culture with stark contrasts. Their descriptions of significant social changes and initial anxieties, as they were introduced into new communities and social structures, were consistent with findings from other studies of post-16 education (Hernandez-Martinez et al., 2011; Rudd & Evans, 1998) but, by the time of the first focus groups, most students had successfully made adjustments, felt socially accepted and were comfortable in the college culture. The students talked about a process of adjustment and negotiation, in which new friendships were developed and personal values were realigned to new cultural norms. This social adjustment within their transition may be explained in terms of a shaping or reconstruction of student identities (Ball, Macrae, et al., 2000) through interactions with new social organisations and groups (Hernandez-Martinez et al., 2011). Student descriptions of their transition from school to college suggest that they had been precipitated somewhat abruptly into a new culture that had swiftly reshaped their identities as learners rather gradually adjusting through a smooth process of change. The move to college involved some key aspects of the transition towards adulthood (Arnett, 2000) but seemed to represent a step-change in the path towards adult life and employment rather than a continuous progression.

The view that student or pupil transitions are best achieved when there is continuity in the curriculum and smooth progression (Hernandez-Martinez et al., 2011; Nicholls & Gardner, 1999) seems inappropriate in this situation, since there were aspects of the discontinuity of this transition that clearly had a positive effect on students. Changes in curriculum, social structures and the organisational culture were seen by students as positive benefits resulting from their move to college. Students who had been disaffected with education in school welcomed the new approaches they found within their vocational programmes, which contrasted with the more formal, controlled learning situation experienced in school. It seems that the transition also brought a new optimism amongst students who encountered different opportunities and expectations in college which, for many, contrasted with their previous failure in the school system. This was a different learning environment that released new possibilities, both within their educational potential and in relation to their future aspirations.

This discontinuity was particularly important with respect to functional mathematics since there was the opportunity to engage with a new curriculum and different teaching approaches in college. For students who had not been successful in school and had become disaffected by their previous experiences, the initial prospect of another mathematics course was often associated with low expectations and evoked negative emotions. The research findings, however, indicate that, for some students, this provided a second chance in which a new view of mathematics in a different learning environment could change their attitude and achievement as learners of mathematics.

6.1.2 Changing images of mathematics

One of the striking features of the research findings was the positive shift in the attitude of some students towards functional mathematics compared to their attitude to mathematics in school as shown in Appendix 3.4 (page 285). The possible causes will be examined further in the following subsections but the difficulty remains of identifying a model or way of understanding these student perceptions of mathematics and associated behaviours, before and after the transition to college. Although a particular aspect of identity will be introduced in the next section that will help to explain these changes in attitude and engagement, attention will be turned first to the ways in which students viewed mathematics in school and college. In order to represent these views, the notion of a personal ‘image of mathematics’ will be introduced since this metaphor seems to have the capacity to capture the mental and emotional pictures that students described in the research.

The depth of emotions and the changed values evident in the research would suggest that the literature on affect could provide a useful model and two possible views might be considered that would incorporate student attitudes, beliefs and emotions. Firstly, the engagement structure proposed by Goldin et al (2011) represents an ‘idealization’ that combines motivations, goals, beliefs, emotional states and meta-affect with behaviour. The examples given of engagement structures such as “Get the job done” or “Don’t disrespect me” or “Stay out of trouble” resonate with some of the student roles observed during lesson observations in colleges and the structure may be useful for analysing the responses of individuals. The use of a structure, however, suggests a more fixed and rigid framework without the flexibility for continuous assimilation of new experiences.

An alternative consideration would be the model used by Di Martino and Zan (2011) to link together emotional disposition, vision of mathematics and perceived competence. This three-dimensional view combines the idea of a personal vision or image of mathematics with emotional responses and self-efficacy beliefs in a construct referred to as attitude, although this differs from more common uses of the term, in which attitude is seen as simply one of several components of affect (J Evans & Wedege, 2004; McLeod, 1992) or as the more stable trait linked to the transient state of emotion (Hannula & Laakso, 2011). My difficulty with this model is that the vision of mathematics is identified separately from the emotional disposition and the student perspectives in the research suggest emotions are deeply woven into their personal images of mathematics.

Adopting the more common view that attitude is a distinct trait within the affective domain, alongside emotions, beliefs and values (J Evans & Wedege, 2004; McLeod, 1992) then the concept of a personal vision of mathematics might then be used to convey a mental schema or framework that is interwoven with associated affective responses. Using this approach, I suggest that a more holistic 'image of mathematics' is a useful model for capturing the personal views of students regarding mathematics, built up from successive encounters with mathematics and the emotions, beliefs and values associated with these experiences.

The descriptions by students in the research would suggest that their existing personal images of mathematics have been constructed from fragmented memories of experiences, superimposed on each other to create a single representation. Particular memories that evoked strong emotional reactions or significant consequences appeared to dominate student descriptions. These might in this model be seen as providing a depth to the image that defined certain features more clearly and a 'colour' that made some elements more, or less, attractive than others. Recurring themes in their personal experiences, such as a lack of agency or success with learning mathematics, also seemed influential in defining student images of mathematics. Using the notion of superimposed sections contributing to an overall image of mathematics, the repetition of similar experiences and emotions would constitute a reinforcement of these aspects and represent their importance to students.

For many students in the study their perception of mathematics was of a remote, difficult and personally inaccessible academic subject of rules, associated with negative emotions and situations of failure. It was also a subject that they believed had no practical use for them except, perhaps, to gain access to further training. Although students often agreed that a mathematics qualification was an advantage for the purposes of gaining employment, it was a subject generally disliked. These characteristics of common student descriptions of mathematics in school suggest that their images are dependent on five particular elements:

- their beliefs about the nature of mathematics (e.g. academic, system of rules)
- the purpose of mathematics in relation to their personal values and goals (e.g. irrelevant)
- their cognitive understanding of the subject (e.g. difficult)
- their emotional responses (e.g. disaffection)
- the position of mathematics with respect to the individual (e.g. remote, inaccessible).

In this way the model incorporates elements that represent the dominant beliefs, values, emotions and cognitive understanding of many students, as evidenced in the research.

The process of image construction, however, did not remain unchanged after the end of formal education in school. Students in college were continually adding new layers to their images, through on-going experiences, which helped redefine or reinforce existing features. My use of the term ‘image of mathematics’, therefore, should be interpreted as a dynamic, changing view of the subject rather than a simple visual representation.

In the study, approaches to the teaching and learning of functional mathematics in different groups varied. It seemed that these either communicated an alternative image of mathematics to the one already constructed from students’ prior experiences, by using contrasting approaches to those encountered in school, or involved similar classroom practices that reinforced existing images. The change to a functional curriculum would suggest that new images of mathematics might be easily constructed on this foundation but this was not always the case in the study. Curriculum implementation seemed to be highly dependent on teachers’ own interpretations and resulted in a range of different approaches. Although teaching approaches will be examined further in a later subsection, it is worth considering, briefly, the different interpretations of the curriculum by teachers at this point since these had significant effects on students’ images.

The differences in interpretation can be summarised by referring to the three distinctive elements of the functional mathematics curriculum highlighted in Chapter 2: application, problem-solving and the use of realistic contexts. Some teachers used approaches that focussed on applications of mathematics rather than the acquisition of knowledge whilst others placed more emphasis on teaching the basic mathematical processes. Applications were often set in contexts intended to appear realistic but some scenarios were more authentic, from a student perspective, than others. Similarly, problem-solving in the functional mathematics curriculum was interpreted by some teachers in a practical sense and there was an emphasis on open tasks with multiple solutions, a choice of methods and opportunity for discussion about alternative ways of solving the problem. This approach presented strong contrasts to the set methods, rigid routines and unique correct solutions students seemed to have associated with mathematics in school and were still used by some teachers in college. In these ways some teachers promoted an image of functional mathematics as a useful ‘tool for life’, with a nature less defined by rules and academic knowledge but more connected to students’ lives and goals. In other classes the subject and the teaching approaches were perceived by students as similar to school and their existing images of mathematics seemed largely unchanged.

Students who were presented with a different image of mathematics by their functional mathematics teachers were often those who also demonstrated a positive change in attitude, engagement and understanding. In order to explain this behavioural change, the construct of identity becomes useful and this will be explained further in the following subsection to show how the dual constructs of image and identity worked together to produce positive effects on students in the research.

6.1.3 Changing identities as learners of mathematics

In conjunction with their images of mathematics, students had perceptions of themselves as learners of mathematics. Many students talked about being unable to understand the subject in school, being ‘outsiders’ in the classroom community, being overlooked or neglected and lacking the agency to improve their understanding or achievement in mathematics. These descriptions bear some resemblance to the key aspects of identity highlighted by Boaler, Wiliam and Zevenbergen (2000) and described as: a sense of belonging to the group, a sense of achievement within the norms of the group and particular behaviours associated with belonging to the group. Although the concept of identity has not been a key part of my approach to the study, it is used by several researchers to explain students’ perceptions of themselves as learners of mathematics (A. Watson & Winbourne, 2007). Interpretations of the term, however, do vary in the literature due to its origins in several different disciplines and consequent variations in meaning (Black, Mendick, & Solomon, 2009). For example, Hernandez-Martinez et al (2011) use the idea of a ‘leading identity’ to explain how students saw learning mathematics in college as a new activity with different motivations compared to those at school, due to a change in their main identity, whilst others consider ‘learner identities in mathematics’ (Bibby, 2009) or ‘pupils’ identities in relation to mathematics’ (Lerman, 1999).

The concept of a ‘social identity as a learner of mathematics’ (Askew, 2008) has been used as a means of describing the varied roles and behaviours of children within their mathematics classrooms. For the purposes of this discussion, this seems an appropriate construct to describe the roles and behaviours that students adopted in school and college. Although descriptions of identities in my study would be different from those used by Askew

(2008), there was evidence of similar enactments in classrooms such as ‘unable to understand’ from Tammy, ‘working hard’ from Simon and ‘not good at maths’ from Damien.

The social identities as learners of mathematics demonstrated by students in college were, in some cases, very different from those they described in their memories of school, whilst other students re-enacted existing identities. Learning functional mathematics in college took place in a social space which might be considered distinct, in the physical and social sense, from mathematics lessons in school and therefore new identities might be expected. Similarities in social structures, however, within some functional mathematics classrooms seemed to cause an overlapping of these social spaces for students, which led to a continuation of, rather than a change in, identity. In other classes the social structures were different from school and these made new identities available to students as learners of functional mathematics.

Within student groups there was often some consistency in the images of mathematics and the types of identity learners adopted, suggesting that factors associated with the class students attended were influential in the construction of these images and identities. In the research it was noticeable that some teachers, for example, Lindsay and Richard, explained how they started the year by discussing with students their perceptions of mathematics and feelings about the subject. The open discussion allowed students to express their current emotions, attitudes, beliefs and fears, thereby providing the basis for an emotionally secure environment (Boaler, 2002; Goldin et al., 2011). Moreover, this gave the opportunity for Lindsay and Richard to develop an alternative culture in which ‘not liking mathematics’ was accepted, although not encouraged. In this way it seems that a new identity as a learner of ‘disliking mathematics but good at it’ became available to students and acceptance of their position of ‘not liking mathematics’ led to a sense of belonging in the functional mathematics classroom.

Within the social structure of the classroom, student relationships with their mathematics teachers also emerged from the analysis as a significant factor, influencing changes in student attitudes and their understanding of mathematics. In the following subsection the role and influence of functional mathematics teachers in the classroom will be examined in more detail to explore how different relationships and teaching approaches had an impact on student learning.

6.1.4 Teaching approaches associated with positive changes in student attitudes

In some groups, such as those taught by Edwin, Keith and Lindsay, students experienced quite dramatic changes in attitude and understanding of mathematics so the characteristics of lessons for these groups are of particular interest. It was noticeable that teaching and learning approaches in the study were very varied and no specific methods could be identified that were consistently used across the positive groups, as illustrated by the categorisation and notes in Appendix 2.4 (page 285). Within the student groups, however, these changes seemed more likely to occur in classrooms where:

- students had strong positive relationships with the teacher
- students perceived that their individual needs were being addressed
- students were provided with clear explanations that they understood
- students were aware of achieving some personal success in learning mathematics
- students understood the relevance of the mathematics they were learning.

These common characteristics of attitude-changing lessons are not independent since, for example, increased relevance often led to more engagement with the learning process and therefore better success. The relevance of functional mathematics will be explored further in the following section but by examining these interlinked aspects of the learning experience some indications of how student attitudes were positively influenced in the study will emerge.

Changes in relationships with teachers were noticed by students in their transition to college but were particularly important in functional mathematics lessons where previous experiences in school often seemed to involve poor relationships with mathematics teachers. In the groups with positive attitudes, the analysis indicates that the social structures in the functional mathematics classrooms were different from school and that relationships with teachers were more equitable. There was a flattening of the power structure within the learning environment and students often viewed their functional mathematics teacher as a ‘friend’ rather than an instructor. This change in role and position was significant because it aligned to values associated with their transition to adulthood that were also reflected in the surrounding college culture.

A student-centred approach, with a particular focus on the individual, was a common feature of positive groups and was often accompanied by greater personal agency for students in the learning process. This was important because students often described their images of mathematics from school as a structured system of rules that had to be tightly followed to achieve the right answer. There had been little place for debate, self-expression or individualism. In some functional mathematics lessons, learning was emergent from the student community rather than teacher-initiated or imposed. This was achieved through the flexible use of student conversations to link mathematics to their recent experiences (e.g. a night out) or discussions around issues of personal interest (e.g. cost of smoking, eating habits and fitness) so the lesson focussed on a student-related issue rather than a mathematical topic.

The focus on the individual was also evident in the flexible structure of some lessons, the willingness to deviate from a lesson plan in order to respond to individual needs and in the lesson time used to support individuals rather than address the class or work in small groups. There was some similarity to the individualised teaching and learning methods associated with adult education and highlighted as good practice for adult numeracy during the Skills for Life Strategy (DfEE, 2001) but these may appear to conflict with other research findings, which indicate that a collaborative approach to learning is beneficial (Swan, 2006). In the observed sessions, however, the emphasis on the individual appeared to be in an environment where discussion and collaboration between students was accepted as a natural part of social interaction in the classroom. The difference was that most collaboration in these classes was relatively unstructured, informal and student-led rather than planned into the lesson. Other studies would indicate that this was not likely to be as effective as a more planned approach to collaborative methods (Boaler, 1999; Swan, 2006) although students clearly found this informal collaboration acceptable and helpful as a part of the learning environment rather than an instructional approach.

Students also described how their attitudes changed once they realised functional mathematics was personally achievable and they began to experience success with mathematical processes or concepts that they had not previously understood. In some cases there were significant gains in understanding, accompanied by a reversal of previously negative emotions, whilst others admitted to enjoying the lessons and making progress whilst still retaining a dislike of the actual subject. This indicates the co-dependency of these features of 'attitude-changing' lessons rather than attributing the changes to a single type of approach.

These characteristics of lessons contributed to the construction of new images and identities for students, which became powerful agents in the processes of re-engagement and improvement in understanding of mathematics. In addition, teaching approaches that increased the relevance of functional mathematics through making connections between mathematics lessons and students’ vocational programmes, or other aspects of their lives, helped shape these images and identities. This brings the discussion towards the second dominant theme of the analysis which examines the visible divisions between functional mathematics and the vocational environment in college, at multiple levels. Whilst considering the difficulties for students and teachers caused by these divisions, some methods of reconciliation that emerged from the study will also be discussed.

6.2 Bridging the academic-vocational divide at multiple levels

6.2.1 A multi-level approach to the academic-vocational divide

For the students in this study, the transition from school to college was also accompanied by a change from an academic environment to a vocationally-orientated learning experience. Concerns about bridging the division between academic and vocational education have frequently appeared in the literature (Pring & Lawton, 1995; Young, 2011) with respect to the curriculum, qualifications and policies within the education system in England, whilst the social class divisions and stratification of knowledge have remained an unresolved concern (Young & Spours, 1998). In this study, the transition from school to college, as analysed in the previous section, showed a discontinuity and, for these students, this represented a swift leap across the academic-vocational divide rather than carefully constructed bridge. Crossing the division into vocational education in a Further Education environment involved significant physical, cultural, intellectual and emotional changes. As students adjusted to the dominant vocational culture in college, their values and expectations were shaped and these changes might be considered as a reversal of priorities since vocational training, rather than academic study, now became their main focus.

Adding a mathematics course into the vocational programme reintroduced the academic-vocational divide at a course level and brought new tensions. Students were situated within several social spaces with different and sometimes conflicting values. The analysis shows how they still retained some awareness of the value of mathematics as an academic subject that had high status and currency value in society whilst, in college, vocationally-related values became dominant. Within a functional mathematics lesson though, students were expected to focus on a curriculum that they initially associated with mathematics as an academic subject and with values that were no longer their main priority. The juxtaposition of these different sets of values and the frequent changes students were expected to make between them during their time in college created tensions that were apparent in their discussions of the value of functional mathematics.

These tensions show some similarity to those evident in attempts to bridge the divide on a national level by 'vocationalising' the academic school curriculum or, alternatively, by adding more subject-based, academic knowledge into vocational qualifications but, as explained in Chapter 2, these strategies present some difficulties (Iannelli & Raffe, 2007; Young, 2011). Historically, convincing parents and employers of the value of a broader type of vocational education has been difficult, whilst the strategy of integrating study that was not practically work-based into vocational education has been viewed with some scepticism by vocational experts. These approaches, according to Young (1998) cannot provide solutions to a multi-faceted problem that is deeply embedded into the education system at multiple levels. Similarly, the findings of this study suggest that the integration of mathematics into a vocational environment is unlikely to be achieved through one means alone since there are multiple levels at which the academic-vocational division creates tensions for students.

In the following discussion these divisions will be viewed as occurring at several different levels to reflect the effects on the student experience due to college staffing structures, vocational culture, departmental policies and classroom practices. At each level, the discussion will illustrate how tensions were either increased or reconciled through the contrasting practices observed in the study.

6.2.2 Divisions in college structures and policies affecting functional mathematics

In Chapter 2 the main two types of staffing structure were described as centralised or dispersed and, in the analysis, some of the advantages and disadvantages to functional mathematics teachers were highlighted. These included the added difficulties for staff from a centralised team maintaining effective communication with the vocational team, the decreased opportunity for connecting functional mathematics to the vocational programme and difficulties associated with a lack of identity with the vocational team.

From a student perspective, centralised staffing was more likely to result in a lack of relevance, due to weak connections between the content of functional mathematics lessons and their vocational programme. It seemed that the dispersed arrangement provided better opportunities to cross the division between functional mathematics and the vocational programme since it brought functional mathematics teachers into daily contact with vocational teachers and provided greater opportunity to make connections that were authentic to students. Furthermore, the integration of functional mathematics teachers into the vocational team meant their identity and role were more aligned to vocational values and priorities. For functional mathematics teachers, however, their interviews suggested that a dispersed structure, involving a separation into different departments or teams with contrasting sub-cultures, contributed to a perception of professional isolation.

The building of bridges to vocational teams did not seem to be achievable without a loosening of connections to other functional mathematics teachers. Some functional mathematics teachers in dispersed arrangements expressed concerns about this isolation of their position from other professionals with similar teaching interests. The separation was evident in comments about the difficulties of attending central meetings or staff training when teachers were subject to conflicting demands from their vocational departments. The absence of a strong functional mathematics professional community was a concern since the separation of functional mathematics teachers from each other resulted in a high level of personal autonomy with respect to classroom practice but little collaboration or peer support in developing effective teaching approaches.

Teaching functional mathematics as an academic subject within a vocational situation also involved a need for some personal reconciliation of the inconsistencies of purpose and ideology represented in the two traditions. Conflicts between personal values and those of the surrounding culture might appear to be eased through the dispersed staffing structure but building connections to the vocational area also produced divisions within the functional mathematics professional community. There was a similarity to the traditional academic-vocational division in which solutions such as 'vocationalising' traditional education were sometimes seen as diluting the academic whilst strengthening the knowledge-base of vocational qualifications was viewed as detracting from the main purpose of vocational training. It seems that bridging the divide might not be achieved without some adjustment of both academic and vocational positions although, in this research, the adjustments took place within a social structure that distributed power to the vocational (Colley et al., 2003) and this influence was evident in the working practices and policies.

In the research, organisational structures and policies reflected a strategy to devolve power to vocational departments and this meant the vocational influence over policy implementation was strong. Generic policies were often moderated by departmental priorities and differences in intended and enacted policies were sometimes significant, even between departments in the same college.

College policies worked in conjunction with other factors such as prior attainment and these factors together had some divisive effects on the student experience by controlling the opportunities available for students. For example, some students who needed to improve their mathematics were denied the opportunity whilst others, who had achieved a grade C in GCSE mathematics and saw no reason to take an additional qualification, found the subject was compulsory. The consequential effects on student attitudes and progress were seemingly unintended but often arose from the pressure to implement policies that maximised financial and quality performance measures rather than student needs.

Tension arose for students when college policies imposed requirements to take a functional mathematics course but the qualification had no apparent value or relevance. Similarly, policies that constrained the level of examination entry were sometimes seen as inappropriate by students, particularly if their test level did not represent any gain on previous qualifications. In these cases, policies reduced the functional mathematics course and the qualification to being an irrelevant academic addition to their vocational programme.

There were ways, however, in which the functional mathematics course and qualification became relevant to students in some classes. These involved bridging the division between mathematics and the students' vocational programme by building connections in a process that emphasised the functional aspects of the curriculum and crossed some of the cultural boundaries between the two disciplines.

6.2.3 Divisions of curriculum and culture in classroom practices

Attention will now turn to examining the academic-vocational divisions that have an impact on classroom practice for functional mathematics. These include issues around the nature of the curriculum, the perceived purpose of functional mathematics and the practical integration of courses; but differences in teaching traditions and the effect of vocational cultural values will also be considered.

The stated purpose of the functional mathematics curriculum is to equip students with the mathematical skills for life and work (QCA, 2007), which follows from a long-standing identified need for adults to be able to apply mathematics in life and work situations (Cockcroft, 1982; DfES, 2005). The intended curriculum is, therefore, aligned theoretically to the goals of many students in vocational education. As we saw in an earlier section of this chapter, teachers' personal interpretations of the functional mathematics curriculum were influential over their classroom practices and affected the images they communicated to students.

Teachers of functional mathematics in the research had varied backgrounds but most had experience of using mathematics in the workplace prior to teaching and this often seemed to strengthen their belief in mathematics as a useful 'tool for life'. In a situation where teachers had a high level of autonomy in the classroom, although subject to demanding performance measures and targets, their classroom practices did seem to largely reflect their fundamental beliefs about the nature of mathematics and how it should be taught. Despite evidence of pressures due to the culture of performativity in colleges (Simmons & Thompson, 2008), in practice, the impact on students was often mediated by teachers (Coffield et al., 2007). As a consequence, teacher beliefs strongly influenced the images of functional mathematics communicated to students and determined whether the subject was seen as an academic discipline or useful 'tool for life'.

Functional mathematics became relevant when students understood that the subject had a practical use in relation to their vocational or personal interests. This rather utilitarian purpose for mathematics was particularly important when the applications were related to their vocational interests or aspirations because this connected mathematics to the main aim of their vocational training, which was preparation for employment in a chosen area. Although this view of mathematics is seen by Ernest (2004) as only a basic minimal goal for school leavers, engagement at this level for many of these students was a significant step beyond their previous disaffection and avoidance.

Discovering a vocationally related purpose for mathematics rather than an academic one was important. It seemed that if the purpose of mathematics was perceived as simply a college requirement to pass an examination then students were not strongly motivated. Some students, who perceived no actual use for the skills in their future lives, saw the main reason for achieving the qualification as a means of bringing their engagement with mathematics to an end. Those who had a clear need for the qualification to access their careers were better motivated but understanding the vocationally-related purpose of functional mathematics seemed to provide the strongest reason for students to engage with the subject.

Most of the teachers in the study attempted to increase the relevance of functional mathematics by trying to build connections to students' vocational or personal interests using contextualised tasks. This use of context resembles the embedded approach widely promoted in the past for adult numeracy teaching and Key Skills and shown to be an effective means of making mathematical processes more accessible and meaningful for students (C. Roberts et al., 2005).

Students' interpretations of contextualised tasks have, however, caused some concern in other studies (Boaler, 1993; Cooper, 2004; Cooper & Harries, 2002), supporting suggestions that realistic contexts have limited value in making mathematics more real although they may aid motivation (Wiliam, 1997). In this research, though, they were an effective means of making connections to students' lives and increasing relevance, when seen as authentic by students and used in conjunction with appropriate teaching approaches. The study and analysis in Chapter 6 show how students' perceptions of relevance may be understood through a three-dimensional framework incorporating the level of connection, the immediacy of usefulness and the depth of interest provided by the context. Where teachers selected scenarios that maximised these dimensions then students were more likely to perceive the tasks as relevant, although the fragile nature of the connections and the constraints of students' life experiences presented some problems. These weaknesses were addressed in some lessons by the use of discussion to strengthen or explain the connections to student lives.

Direct links were made between some functional mathematics schemes of work and the vocational programme by planning to teach the mathematics required for a vocational element just prior to it being used in the vocational course. This was a means of making strong connections and increasing student perceptions of relevance but few actual examples of these links were provided in observations or focus groups. The reasons why such an approach, which has been promoted previously as part of an effective embedded strategy for Key Skills (Eldred, 2005; C. Roberts et al., 2005) was not more widely adopted is difficult to establish from the limited evidence in this study but seems to indicate a neglected aspect of functional mathematics teaching with some potential for helping bridge the divide.

Despite the efforts of functional mathematics teachers to make these connections, the research shows how practical issues, such as rooming or timetabling, created impressions that functional mathematics lessons were isolated from the vocational course. This reinforced the view that the subject was only a secondary addition to the student programme rather than an essential element. Although this may seem insignificant compared to other aspects of integration, students were sensitive to practical inconveniences and these aspects seemed to implicitly communicate the priority of the vocational programme over functional mathematics sessions.

The final aspect of teaching functional mathematics for consideration became evident from observations of vocational sessions and concerns the vocational nature of the college culture. In some functional mathematics lessons there was evidence of the duality of academic and vocational values being integrated into the classroom culture whilst in others an academic approach was employed with no adjustment to the surrounding vocational culture. Suggestions in the literature that teachers in Further Education need an awareness of how their subject fits within the college context (Robson, 2006) seem particularly pertinent to the cultural aspects of the integration of functional mathematics lessons into a vocational programme.

The fragmentation of college culture and the differences in values between departments also became apparent in the study. For example there were strong values, such as team work, within Public Services departments that were less visible in Hairdressing or Construction. Embedded occupationally-related values of vocational departments still seemed to be present in Further Education colleges, as indicated in the literature (Colley et al., 2003; Unwin, 2009), presenting cultural divisions that were difficult for functional mathematics teachers to cross, particularly when teaching in several vocational areas. As Lindsay explained, she understood Sports students but found it difficult to identify with groups from some other departments, indicating how, in her experience, student groups in different vocational areas did not hold the same basic values or priorities. Relating to these students personally was a problem yet, as explained earlier, student-teacher relationships were important in changing student attitudes and engagement.

Tensions occurred because students adopted the cultural values associated with their vocational department and made assumptions that were not necessarily understood or shared by functional mathematics teachers who had their own values and expectations. In Lindsay's case, her groups of Public Services students clearly appreciated the way she responded to them and seemed to share their values. Although retaining some elements of a formal approach, her classroom did reflect some aspects of the vocational culture. In contrast, there were unresolved tensions in David's groups where students could not understand why they were not allowed to discuss their work in class, which conflicted with the values of team work and collaboration that were encouraged in Public Services classrooms.

In these ways, divisions between functional mathematics and the vocational programme were sometimes exacerbated by particular classroom practices, whilst in others attempts were made to bridge the divide. The more successful approaches highlighted in this section may be considered as a 'vocationalisation' of mathematics through the use of a vocationally-related curriculum, in conjunction with teaching methods that reflected vocational aims and values. Alternatively, placing a mathematics course into a vocational programme could be viewed as adding an academic component into vocational training. From either viewpoint, the strategies used in the study represent ways of dealing with the dissonance between mathematics and vocational education that arises in colleges. These two strategies show an interesting similarity to national initiatives that have historically attempted to bridge the academic-vocational division in the curriculum by bringing a 'new vocationalism' into the school curriculum or introducing more academic content into vocational qualifications (Lea et al., 2003; Lucas, 2004).

These practices in colleges may be seen as a type of multi-level embedding, in which different aspects of the learning process for functional mathematics, such as the curriculum, the contexts of tasks, the teaching approaches and the classroom culture, were each connected to the vocational programme. Establishing these connections, however, required functional mathematics teachers to understand student interests, vocational values and departmental cultures. Although vocational teachers stated their support for functional mathematics, it seems that bridging the divide in this study was largely dependent on functional mathematics teachers, as representatives of the academic subject of mathematics, developing an understanding of the vocational perspective and constructing their own bridges before they could lead students along a similar pathway.

6.3 Summary

Having explored the themes of transition and the academic-vocational division, much of the analysis that relates to the research questions has now been discussed. In this section, to add clarity, each of the research sub-questions will be revisited in turn to briefly summarise the main findings.

6.3.1 What effects do college policies, systems and organisational cultures have on the student experience?

- Policies worked in conjunction with other factors (e.g. prior attainment) but there were often negative consequences of college policies for students that seem to be overlooked and pressure to maximise financial and quality performance measures sometimes seemed to take precedence.
- Enacted policies sometimes restricted student opportunities to improve their mathematics, or led to negative attitudes due to policies that did not appear appropriate from a student perspective, such as taking functional mathematics when they already had GCSE mathematics at grade C.
- Power was often devolved to departments and enacted policies were influenced by individual vocational departments. This resulted in differences between departments that caused tensions and some indications of vocational priorities taking precedence.
- Systems and structures within colleges resulted in a high level of autonomy for functional mathematics teachers in their classroom practices, particularly in a dispersed arrangement where they were isolated from any functional mathematics professional community.
- There was a lack of professional identity for functional mathematics teachers due to factors such as dispersed staffing, a lack of consistency in training routes and difficulties providing structured programmes of professional development.

6.3.2 What influence does the prior experience and background of students have on their attitude and experience of functional mathematics?

- Many students described their experiences of mathematics in school in terms of negative attitudes and showed some emotionally sensitivity towards the subject. Low attainment and identification with failure led to low confidence, self-efficacy and resilience. Students' experiences of difficulty during school mathematics lessons often led to perceptions of being overlooked, neglected, having a lack of agency and not belonging in a mathematically-orientated learning community.
- Student images of mathematics reflected these aspects of their previous experiences and often resulted in perceptions that mathematics was a difficult, irrelevant, remote, inaccessible, academic subject that was associated with negative emotions.
- Students experienced significant changes in their transition to college but these were generally viewed positively. New social structures, responsibilities and personal agency in college contrasted with their experiences of school but represented important values in their broader transition to adulthood.
- Discontinuity was a positive aspect of the transition since it presented alternative opportunities, contrasting with their previous experiences of education and in some cases presented them with a different view of mathematics.
- Attitudes to functional mathematics in college were generally more positive than they were towards school mathematics and there were significant attitude changes for students in some functional mathematics groups.

6.3.3 What approaches to teaching functional mathematics are being used and what effect do they have on student learning?

- Teaching and learning approaches in the research were varied and there seemed to be no consistency across or within colleges although there was some evidence of different traditions associated with vocational, academic and adult education.
- In functional mathematics classrooms, some teachers created a different social structure and classroom culture in which students had greater agency and relationships were more equitable.
- Within the classroom, positive changes in attitude and achievement seemed more likely when: students saw the relevance of the subject, experienced some success in learning, had positive relationships with their teachers and their individual needs seemed to be addressed.
- The construction of new images for mathematics and identities as learners of mathematics were facilitated through teaching approaches that effectively embedded functional mathematics into the vocational environment.
- Teaching approaches that communicated functional mathematics as a useful 'tool for life' had a positive impact on student attitudes and engagement since students could then relate mathematics to vocational purposes.
- Similarities in teaching approaches, classroom culture and teacher-student relationships between functional mathematics and vocational sessions helped reconcile the differences between a subject associated with academic education and the vocational environment.
- Teachers of functional mathematics had varied backgrounds but their experience of using mathematics in the workplace influenced their beliefs about functional mathematics, their interpretation of the curriculum and the image of mathematics they communicated to students.

6.3.4 In what ways is functional mathematics relevant to students on vocational programmes?

- Students who understood that functional mathematics had a value or usefulness for their lives were more positively orientated towards learning the subject.
- Relevance for students was established through the value of the qualification or the skills in relation to their vocational or personal goals. This generally involved identifying connections, discovering a use-value and establishing a positive emotional response.
- Contextualised tasks helped students make connections to their lives and increased their perceptions of relevance if they were able to make meaningful links and identify a use-value for the skills. The level of connection to the context, the immediacy of usefulness and the strength of interest or affiliation were important dimensions that affected their perceptions of relevance regarding the contexts of tasks.
- Functional mathematics was situated within college practices at three levels: learning (activities or tasks), culture (vocational) and policy (intended and implemented). In each context students need to see meaningful connections to their lives and goals in order to understand the relevance of their functional mathematics course.

Chapter 7: Conclusions

The analysis and discussion within the preceding chapters show the complexity of the situation for students who were learning functional mathematics in a college environment as an addition to their vocational programme. In this chapter the main points from the analysis and discussion will be revisited to draw conclusions about the student experience before considering areas for further study that arise from this research, reflecting briefly on my personal learning journey and highlighting the contribution of this thesis to knowledge.

7.1 Main conclusions and implications

Having commenced by stating that this research was on the boundaries of mathematics education, adult education and Further Education, the findings would support the view that this student cohort has some unique characteristics associated with their age and learning situation. The vocational orientation of their education differentiated them from students at a similar age in schools but the limitations of their current life experience distinguished them from more mature adults in Further Education. Although not yet entering the adult world and often still viewed as adolescents, there were characteristics and values of this student group that Arnett (2000) would associate with emerging adulthood and others would connect to important markers in a transition towards adult life and work (Côté & Bynner, 2008). Most would not view this age group as a separate life phase but, educationally, this is a distinct student cohort that has emerged historically from wider changes in society and educational policies such as reduced youth employment opportunities and the post-16 division into academic and vocational pathways. These structures have created the space and conditions in which low-attaining students aged 16-19 have restricted choices and are often strongly directed towards identities as young vocational learners in Further Education colleges.

Their distinctive educational situation has some impact on their experience of mathematics in college, which is positioned between past experiences, frequently associated with failure and disaffection, and future expectations, which are largely focussed on vocational employment and adult life. At this section of time within their life course both the past and the future exert influences on their learning of functional mathematics and need to be taken into account in the teaching approaches used within functional mathematics classrooms. The legacies of the past have significant effects on their approaches to learning mathematics but vocational goals and interests provide a source of motivation. In this interim phase between formal education and vocational employment mathematics assumes a purpose and relevance only if it can be connected to their new goals rather than their past failures.

The research showed how these students were affected by a range of socio-cultural influences associated with their learning situation in college but individual emotions and attitudes towards the subject had a significant impact. The social, emotional and cognitive dimensions suggested by Illeris (2003) were evident in multiple ways. Student responses to learning functional mathematics were affected by the social structures within the classroom, their relationships with teachers and the cultural values within their learning situation but these classroom experiences were set within a framework of college policies and systems that also shaped their perceptions. Within this network of interacting social factors, students' affective responses were closely linked to cognitive processes. Success and enjoyment in college functional mathematics lessons were intertwined, although the emotional legacy from school mathematics classrooms was sometimes difficult to leave behind. Previous disaffection, disengagement and recollections of failure often lingered and affected students' initial responses to functional mathematics in college. The importance of affective, social and cultural factors for these students was a strong theme which has implications for in-service and pre-service teachers of mathematics in Further Education since teaching approaches clearly needed to address far more than simply the cognitive development of students.

The students in this study had undergone a significant transition from school to college between two contrasting learning situations with different aims and values. Changes associated with their transition to adulthood were important, even though this was likely to be a protracted and fragmented pathway. Within college, students quickly adopted values associated with adult life and employment through exposure to the vocationally-orientated culture, leading to expectations that functional mathematics lessons would incorporate similar cultural features. When compatible values were reflected in functional mathematics classrooms there was greater cultural coherence in the student experience, whilst traditional approaches to teaching mathematics often resulted in tensions. This highlights the wider awareness needed by teachers in Further Education of the positioning of mathematics within a vocational learning environment in order to develop appropriate teaching approaches that reflect those of the surrounding organisational culture.

Within the student experience there were multi-level fractures between mathematics as an academic subject and the vocational training that was the students' main priority. Contrasts in the curriculum, the approaches to teaching, the learning environment and the cultural values implicit in different learning situations created a dissonance in the student experience. This often contributed to a perception that mathematics was an isolated academic discipline in relation to students' vocational orientation.

In some cases individual teachers were able to connect functional mathematics to the vocational environment through meaningful contextualised tasks and teaching approaches that communicated an image of mathematics as a useful 'tool for life'. Multi-level approaches to embedding mathematics, which included aspects of policy, timetabling and structural organisation alongside these teaching approaches; were effective in making the student experience more consistent and meaningful at a local level but there remain questions about whether this academic-vocational integration is really achievable without fundamental policy changes at a national level. This raises several issues regarding the on-going presence of this historical division within the English education system. Adding mathematics in any form to a vocational programme may lead to some tensions between ideologies and educational purposes but the current emphasis on prioritising the academic GCSE mathematics qualification for vocational students seems destined to increase the polarisation of the student experience and create greater dissonance. Bridging the divisions within the student experience, in the ways suggested in this study, may provide a more coherent programme and more meaningful images of mathematics but the long-standing nature of organisational, curriculum and knowledge divisions, strongly associated with inequalities and social class, suggests that achieving harmony is difficult.

The functional curriculum was fundamental to the development of teaching approaches that presented a new image of mathematics but also seemed closely aligned to the skills required for the workplace. A curriculum that emphasised problem-solving in 'real life' situations could facilitate the construction of meaningful connections to students' vocational or personal interests. In conjunction with a new image of the subject, some teachers also made new identities available to students as learners of functional mathematics through a classroom culture that was characterised by close student-teacher relationships, more equitable roles, less hierarchical social structures and student-centred approaches. These images and positive identities as learners were key features of case study groups in which students' attitudes became more positive. This often resulted in a re-engagement with learning, better understanding of the subject and gains in confidence. The process of creating new images of mathematics and identities as learners would seem, therefore, to provide an essential first step towards better achievement and confident future application of mathematics in the workplace.

Recent changes in national policy, however, suggest that attaining a minimum standard with the more academic GCSE curriculum is a higher priority. The argument for equity, in terms of all students having the opportunity to achieve an accepted minimum level and a recognised qualification in mathematics, seems to be founded on the assumption that GCSE mathematics is a suitable and accessible curriculum for all students. The findings from this research present an alternative view of the situation since disengaged, low-attaining students discovered greater relevance for mathematics and were more readily re-engaged using the functional curriculum, in conjunction with teaching approaches that presented functional mathematics as a useful and relevant ‘tool for life’. Although the image suggested here may only reflect a utilitarian purpose for the subject, this was a significant factor in creating new identities for students and seemed to provide a reason to engage with mathematics that an academic image did not supply.

Current policy directs students away from this opportunity for engaging with an alternative, and seemingly more relevant, curriculum thereby denying access to the attitude-changing experience of mathematics made possible in these case studies through the functional approach. Despite the development of a new GCSE specification since the commencement of this research, it seems unlikely that an academic GCSE mathematics qualification can offer the same potential to vocational students for the transformation of image and identity that the functional curriculum provided in this study.

There appears to be some duality of purpose in the current policy situation between encouraging all students to attain a minimum academic standard in mathematics and ensuring they become equipped with the appropriate mathematical skills for the workplace. The research findings indicate a conflict between these two purposes, suggesting that vocational students may derive more benefit from focusing on the development of functional mathematics with a restricted range of curriculum content than trying to extend their academic knowledge of the subject and failing to develop the application skills essential for the workplace. Although equality of opportunity is important, for those intending to follow vocational pathways into a workplace where higher level skills are not required (Hodgen & Marks, 2013), the policy may create disadvantage rather than equity since it seems likely to result in continuing disengagement and failure for vocational students with a subject that holds little apparent relevance.

For the students in this study, their formal education had often left a legacy of failure and disaffection but, within a contrasting learning environment, using an alternative mathematics curriculum and different classroom practices, some of these learners experienced a reversal of these negative attitudes and were able to make significant gains in understanding. It seems that the discontinuities in educational institution, curriculum, teaching approaches and learning environment at age 16 were beneficial to these students rather than detrimental but coherence with their vocational learning programme was essential to resolving some of the inherent tensions between mathematics and the surrounding learning environment. Student descriptions of their negative experiences of mathematics in schools but relative success in college raise questions about the suitability of the current education system to meet the needs of those with non-academic intentions without a significant change in their learning situation, either pre-16 or post-16.

7.2 Areas for further development

In view of the limited attention paid to this area in the past, there is need for additional research that focuses on the learning experience of this distinctive educational cohort in relation to the mathematical demands of their future life and work. Research into workplace mathematics provides a valuable foundation to develop a curriculum appropriate for the purposes of preparing vocational students for a range of different types of employment. The functional mathematics curriculum, although rejected by schools, prioritises some of the mathematical skills indicated as important for the workplace and is worth some further examination.

In view of the recent policy changes, a suggested direction for further research would be to examine the actual impact on attainment over time of different mathematics curricula in post-16 education. This limited study has developed an understanding of the student learning situation based predominantly on qualitative data but a more quantitative approach would seem appropriate to include in further research. Quantitative measures of attainment for low-attaining students in post-16 education are currently available as large data sets. Using these in conjunction with some more focussed studies of student progression between mathematics courses and qualifications over a period of two to three years would provide a more extensive evidence base than this small scale and largely qualitative study. Tracking the progress and attainment of students does, however, present some issues since the research has shown how local college and departmental policies influence levels of examination entry and student pathways regarding mathematics are sometimes fragmented. In view of the potential unreliability of this data as a measure of individual attainment then the research may need to be supplemented by further selected case studies in which alternative measures of student progress are used alongside qualitative methods to analyse the actual learning gains for students with different curricula.

The study showed that a wide range of teaching approaches was being used in colleges for functional mathematics, some with greater effectiveness than others. A focus on the needs of the individual seemed to be valued by students and contributed to gains in understanding. Although some common features were identified for groups in which significant changes occurred in attitude and understanding, these improvements were also influenced by socio-cultural effects on the learning process. There remains some uncertainty about the actual teaching methods that helped students develop sound conceptual understanding in this learning situation. In view of the distinctive nature of this student cohort then adopting methods from schools-based research or adult education seems inappropriate without further research in the context of vocational education.

The professional status, identity and training of functional mathematics teachers for Further Education is an additional issue that has been raised through this research and would warrant further investigation. The current focus of government policy is on increasing the subject knowledge and pedagogical content knowledge of functional mathematics teachers to equip them to teach at GCSE level and recruiting high-achieving mathematics graduates into teaching within colleges. These strategies overlook the importance of understanding the environment in which this learning will take place and how mathematics can be made relevant to students, both of which were significant factors that affected the student experience. In the light of this study it seems unlikely that learning mathematics in colleges will become successful for vocational students at this level whilst curriculum and teaching methods replicate those associated with an academic image of mathematics rather than the useful ‘tool for life’ that enabled access to a more positive student experience.

The study also demonstrates the diversity within Further Education colleges, the practical difficulties and the possible limitations that may be encountered in any future research within this sector. The over-arching impression gained through this study, however, is of the neglect of this student cohort in research studies and the consequent lack of understanding of their perceptions or needs that is reflected in government policy. Until this inequity is addressed it seems likely that policy decisions will continue to reflect the mathematical needs of those destined for an academic future whilst the learning experience of those on vocational pathways continues to be overlooked and their views under-represented.

7.3 Personal reflections

Finally, I will return to my personal starting point for this research and consider my own progress from those early personal experiences of teaching mathematics to vocational students. The research process has involved the deconstruction of certain assumptions and perceptions that were founded on my own informal observations whilst working in colleges. This has been followed by a repositioning of some of these fragments into a more robust framework formed from a systematic analysis of the situation. Through this process of reconstruction my perspective of the students' learning situation has gradually been shaped and changed as some elements of the background have moved into the foreground and some factors initially identified as significant have become even more prominent.

In particular, the study has shown the importance of understanding the wider context in which the student learning of mathematics takes place, including the historical, cultural and organisational traditions that have helped to define the current situation. Mathematics is not a value-free subject that can be placed into this situation without a consideration of its purpose and a careful positioning into its surroundings. Combining research methods and analysis with the illumination of personal experience in this way has provided some clearer insight into the student learning situation and offered some possible solutions to problems that had featured strongly in my previous roles as a teacher and manager but has also highlighted the value of taking a wider perspective of the student learning experience.

One of my concerns throughout this study has been the absence of a clear theoretical framework but with a study intended to be fairly exploratory and 'theory-seeking' it inevitably becomes easier to see the direction the research may have taken after the event. When planning the study it was not possible to predict which aspects of the student experience would emerge as significant factors and move into the foreground but there are particular features that have become important and would therefore be key considerations in further research studies of similar groups. Social, cultural and emotional factors were particularly significant for these students and strongly influenced their learning experience of mathematics in a variety of ways. As a result the focus of the research has gradually shifted towards a more sociological approach and this would, perhaps, have been an alternative starting point rather than my rather holistic view of the situation.

In addition to the main concepts that formed the foundation for the research, other constructs have emerged, such as identity and motivation, which would be useful to explore in relation to the student experience. There are several decisions that may also have been made differently during the research and certainly reducing the scope of the study at the beginning would have made some aspects of data collection and analysis less complex.

Carrying out the study has been a personal learning journey from which many conclusions can be drawn, apart from the findings in this thesis. For teachers and managers in Further Education there are indications from the research of ways in which actions, both inside and outside the classroom, may lead to improvements in the student experience and more positive outcomes. As a researcher, however, my conclusion is that this is still a neglected and under-researched area in urgent need of attention in order to inform the road to improvement.

My personal contribution to knowledge through this thesis has been primarily to explore and map out the terrain, thereby providing better understanding of the factors that most strongly affect the learning experience of vocational students in Further Education colleges. This is an important foundation on which further research can now be built. The findings indicate the importance of factors related to two dominant themes:

- the transition from school to vocational education, in which student values are rapidly re-orientated towards their personal progression to adulthood and employment
- the inherent academic-vocational divisions at multiple levels within colleges that affect the positioning of mathematics within the students’ vocational experience.

In conjunction with these themes, I have introduced the concept of an image of mathematics and a three-dimensional framework for understanding student perceptions of relevance. As additions to existing constructs, these are used to explain how students in some classes who were previously disaffected with mathematics adopted new identities as learners of functional mathematics, became re-engaged and achieved a better understanding of the subject. Alongside some indications of the methodological issues to be overcome when working within Further Education colleges, these themes, concepts and key findings provide a valuable addition to existing knowledge in this area and a much-needed basis for the development of further studies.

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APPENDIX 1: Data-collection tools

1.1 Questionnaire for functional mathematics teachers

Questionnaire for functional mathematics teachers

This questionnaire is part of a PhD research project being conducted at the University of Nottingham to study the student experience of functional mathematics for vocational students in Further Education. The aim is to gain a better understanding of the factors that influence this experience, particularly those affecting student engagement, participation and success.

Your contribution to this research is valuable and you are welcome to contact me using the details below if you have any further questions. All contributions will be treated confidentially and will be made anonymous in research reports. Data will be stored securely and only used for the purposes of the research. If you agree to participate then you still have the right to withdraw from the research at any time.

Thank you for your help.

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There are six sections in this questionnaire and the purpose is given at the start of each section. The questions should be fairly quick to answer and the whole questionnaire should take about 15min to complete.

SECTION A

This section is about your background and role in college.

Q1 **Gender** *(please circle)*

Male Female

Q2 **Are you currently working full-time or part-time for the college?** *(Please circle)*

Full-time Part-time

Q3 **Are you employed on a permanent or temporary basis?** *(Please circle)*

Permanent Temporary

Q4 **For how many years in total, to the nearest year, have you worked as a teacher or lecturer?** *(Please include both part-time and full-time work, in both colleges and schools)*

___________ Years

Q5 **For how many years have you worked as a teacher in this college?**

___________ Years

Q6 **In which department and site are you based?** Dept ______________________ Site ______________________

Q7 **In which vocational areas did you work in 2011/12 as a functional maths teacher?** *(If you worked in more than one area then please circle all that apply)*

Animal Care	Art and Design	Business	Construction	Engineering
Hair and Beauty	Horticulture	IT	Sport	Travel and Tourism
Childcare	Health and Social Care	Public Services	Performing Arts	Automobile
Science	Media	Other (please state) ________________		

Q8 **What were the main subjects/courses that you taught in 2011/12 in college?** e.g. GCSE Maths, functional maths. *(Please start with the subject/course you teach for the most hours)*

1. ______________ 2. ______________ 3. ______________ 4. ______________

Q9 **Which of these subjects do you prefer teaching, if any?** *(If applicable, please give one or more preferences)*

1. ______________ 2. ______________ 3. ______________

Q10 **Do you currently have any other roles or responsibilities within the college?** *(please circle all that apply)*

Manager T&L Observer Subject leader Personal tutor Other ___________

SECTION B

This section is about your perceptions of functional mathematics.

Q11 How would you personally describe the meaning of the term functional maths?

____

____

For the following questions, please circle the appropriate number to indicate your response to each statement.

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Q12	**What is functional maths?**					
	Functional maths is the same as basic numeracy	1	2	3	4	5
	Functional maths involves real-life applications	1	2	3	4	5
	Functional maths is about developing problem-solving skills	1	2	3	4	5
	Functional maths requires reasoning and thinking skills	1	2	3	4	5
	Functional maths is similar to GCSE	1	2	3	4	5
	Functional maths is the maths needed for real life	1	2	3	4	5
	Functional maths is the maths needed for the workplace	1	2	3	4	5
	Functional maths skills are transferable to different situations	1	2	3	4	5

SECTION C

This section is about vocational students and their experience of functional mathematics.

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Q13	**Which of the following statements do you agree with?**					
	Students find functional maths relevant to their current life experience	1	2	3	4	5
	Functional maths skills help students with their vocational course	1	2	3	4	5
	Students will use the skills they learn in their personal lives in the future	1	2	3	4	5
	The skills they learn in functional maths will be useful in the workplace	1	2	3	4	5
	A functional maths qualification will help students gain employment	1	2	3	4	5
	Students gain confidence from passing a functional maths qualification	1	2	3	4	5
	Students need the qualification to progress to the next vocational course	1	2	3	4	5
	Students will progress further in their careers with the qualification	1	2	3	4	5
	Students enjoy functional maths	1	2	3	4	5
	Students want to succeed with functional maths	1	2	3	4	5
	Students are interested in functional maths	1	2	3	4	5
	Students develop confidence in functional maths sessions	1	2	3	4	5
	Learning functional maths is a positive experience for students	1	2	3	4	5

SECTION D

This section is about your approach to teaching functional maths.
Please circle the appropriate number to indicate your response to each statement.

		Almost never	Sometimes	About half the time	Most of the time	Almost always
Q14	**In my functional maths sessions**					
	Students work individually on written tasks or questions	1	2	3	4	5
	Students work collaboratively in pairs or small groups	1	2	3	4	5
	I explain the topic before students attempt the questions	1	2	3	4	5
	Students discuss and explain their ideas to each other	1	2	3	4	5
	The students practice once I have taught them the methods	1	2	3	4	5
	Students do work on their own using worksheets or textbooks	1	2	3	4	5
	Students work individually using computers	1	2	3	4	5
	Students get involved in discussions and ask questions	1	2	3	4	5
	Students work on tasks that require problem-solving approaches	1	2	3	4	5
	I break down problems into simple steps for students	1	2	3	4	5
	Students explain their own ideas about how to solve a problem	1	2	3	4	5
	I teach students strategies for solving problems	1	2	3	4	5
	I test students' understanding with simple closed questions	1	2	3	4	5
	Students do tasks that develop their reasoning and thinking skills	1	2	3	4	5
	Students practice on developing their basic numeracy skills	1	2	3	4	5
	I use open-ended questions with students	1	2	3	4	5
	I use scenarios and problems that would occur in real life	1	2	3	4	5
	The maths we do is linked to the students' vocational course	1	2	3	4	5
	Students do tasks in a work-related context	1	2	3	4	5
	The context used would relate to the interests of most students	1	2	3	4	5
	I use scenarios relevant to the students' current lives	1	2	3	4	5
	Students do tasks set in a vocational context relevant to them	1	2	3	4	5
	Students practice skills that do not require a context	1	2	3	4	5
	Students do similar tasks to ones that occur in the workplace	1	2	3	4	5

Please use the space below for any further comments about teaching functional mathematics:

SECTION E

This section is about your general experience of working in the college.
Please circle the appropriate number to indicate your response to each statement.

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Q15	**How would you describe your relationships with vocational areas?**					
	We work together to develop maths tasks for students	1	2	3	4	5
	I have a good working relationship with the vocational staff	1	2	3	4	5
	We regularly discuss students and their progress together	1	2	3	4	5
	There is tension between vocational staff and functional maths staff	1	2	3	4	5

Q16 How often do you communicate with vocational staff on average? *(Please circle)*

Once a term or less   Once a month   Once a week   Once a day   More than once a day

Q17 What do you communicate about most often? *(Please circle or state alternative)*

Student progress   Student behaviour in class   Attendance and punctuality   Functional Maths

Vocational subject   Practical arrangements   Other (please specify) ____________________

Q18 Which means of communication do you use most often? *(Please circle all that apply)*

Email   College forms   Phone   Informal face-to-face   Formal meetings   ProMonitor system

Other (please specify) ________________

SECTION F

This section is about yourself and mathematics.
Please circle the appropriate number to indicate your response to each statement

		Strongly disagree	Disagree	Neither agree nor	Agree	Strongly agree
Q19	**How do you feel about your own experience of maths?**					
	Maths is a subject that I liked at primary school	1	2	3	4	5
	Maths is a subject that I liked at secondary school	1	2	3	4	5
	Maths is a subject that I like today	1	2	3	4	5
	The maths I learned at school has been useful in my personal life	1	2	3	4	5
	The maths I learned at school has been useful in my career	1	2	3	4	5

Q20 What is the highest qualification in maths that you passed at school? *(please circle, or state alternative)*

GCSE   O level   CSE   A level   AS level   Other (please state) __________________

Q21 What maths have you studied or additional maths qualifications have you achieved since school?

____

Q22 Which of the following teaching qualifications do you hold? *(Please circle all that apply)*

PGCE   Cert Ed   Other teaching qualification (*please state)* ______________________________

Specialist qualification for teachers of Adult Numeracy (Level 4 or 5)

Combined PGCE with specialist qualification for teachers of Adult Numeracy

Q23 Please give details of any other HE qualifications that you hold (e.g. degree, HND)

Qualification ___________   Subject(s) ___________________________

___________   ___________________________

Please use the space below for any further comments:

Thank you for taking part in this questionnaire.

As part of this research project , I am keen to conduct some individual interviews to explore staff views in more depth. The interviews will take no more than 45min, can be arranged at a time to suit you and will be confidential. I would be grateful if you could provide your name and college email address in the space below so that I can contact you regarding these interviews . This information will be used solely for the purpose of contacting you and your contributions to the research will remain anonymous and confidential. If you do not wish to take part in an interview then please leave this section blank.

Name ___________________________   Email ___________________________

1.2 Questionnaire for vocational teachers

Questionnaire for vocational staff

This questionnaire is part of a PhD research project being conducted at the University of Nottingham to study the student experience of functional mathematics for vocational students in Further Education. The aim is to gain a better understanding of the factors that influence this experience, particularly those affecting student engagement, participation and success.

Your contribution to this research is valuable and you are welcome to contact me using the details below if you have any further questions. All contributions will be treated confidentially and will be made anonymous in research reports. Data will be stored securely and only used for the purposes of the research. If you agree to participate then you still have the right to withdraw from the research at any time.

Thank you for your help.

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Professor Malcolm Swan. Email: malcolm.swan@nottingham.ac.uk

There are five sections in this questionnaire and the purpose is given at the start of each section. The whole questionnaire should take about 10min to complete.

SECTION A

This section is about your background and role in college.

Q1 **Gender** *(please circle)*

Male Female

Q2 **Are you currently working full-time or part-time for the college?** *(Please circle)*

Full-time Part-time

Q3 **Are you employed on a permanent or temporary basis?** *(Please circle)*

Permanent Temporary

Q4 **For how many years in total, to the nearest year, have you worked as a teacher or lecturer?** *(Please include both part-time and full-time work, in both colleges and schools)*

___________ Years

Q5 **For how many years have you worked as a teacher in this college?**

___________ Years

Q6 **In which department are you based?** Dept ____________________________ Site _________________

Q7 **In which vocational areas do you work ?** *(If you work in more than one area then please circle all that apply)*

Animal Care	Art and Design	Business	Construction	Engineering
Hair and Beauty	Horticulture	IT	Sport	Travel and Tourism
Childcare	Health and Social Care	Public Services	Performing Arts	Automobile
Science	Media	Other (please state) _________________		

Q8 **What are the main subjects/courses that you currently teach in college?** *(Please start with the subject /course you teach for the most hours)*

1. _______________ 2. _______________ 3. _______________ 4. _______________

Q9 **Which of these subjects do you prefer teaching, if any?** *(please give one or more preferences if applicable)*

1. _______________ 2. _______________ 3. _______________

Q10 **Do you currently have any other roles or responsibilities within the college?** *(please circle all that apply)*

Manager T&L Observer Subject leader Personal tutor Other ___________

SECTION B

This section is about your perceptions of functional mathematics.

Q11 How would you personally describe the meaning of the term functional maths ?

____

____

For the following questions, please circle the appropriate number to indicate your response to each statement.

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Q12	**What is functional maths?**					
	Functional maths is the same as basic numeracy	1	2	3	4	5
	Functional maths involves real-life applications	1	2	3	4	5
	Functional maths is about developing problem-solving skills	1	2	3	4	5
	Functional maths requires reasoning and thinking skills	1	2	3	4	5
	Functional maths is similar to GCSE	1	2	3	4	5
	Functional maths is the maths needed for real life	1	2	3	4	5
	Functional maths is the maths needed for the workplace	1	2	3	4	5
	Functional maths skills are transferable to different situations	1	2	3	4	5

SECTION C

This section is about vocational students and their experience of functional mathematics.

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Q13	**Which of the following statements do you agree with?**					
	Students find functional maths relevant to their current life experience	1	2	3	4	5
	Functional maths skills help students with their vocational course	1	2	3	4	5
	Students will use the skills they learn in their personal lives in the future	1	2	3	4	5
	The skills they learn in functional maths will be useful in the workplace	1	2	3	4	5
	A functional maths qualification will help students gain employment	1	2	3	4	5
	Students gain confidence from passing a functional maths qualification	1	2	3	4	5
	Students need the qualification to progress to the next vocational course	1	2	3	4	5
	Students will progress further in their careers with the qualification	1	2	3	4	5
	Students enjoy functional maths	1	2	3	4	5
	Students want to succeed with functional maths	1	2	3	4	5
	Students are interested in functional maths	1	2	3	4	5
	Students develop confidence in functional maths sessions	1	2	3	4	5
	Learning functional maths is a positive experience for students	1	2	3	4	5

SECTION D

This section is about your experience of working in the college.

		Strongly disagree	Disagree	Neither agree nor	Agree	Strongly agree
Q14	**How would you describe your relationships with functional maths staff?**					
	We work together to develop maths tasks for students	1	2	3	4	5
	I have a good working relationship with the functional maths teachers	1	2	3	4	5
	We regularly discuss students and their progress together	1	2	3	4	5
	There is tension between vocational staff and functional maths staff	1	2	3	4	5

Q15 How often do you communicate with functional maths staff on average? *(Please circle)*

Once a term or less Once a month Once a week Once a day More than once a day

Q16 What do you communicate about most often? *(Please circle or state alternative)*

Student progress Student behaviour in class Attendance and punctuality Functional Maths

Vocational subject Practical arrangements Other (please specify) ___________________________

Q17 Which means of communication do you use most often? *(Please circle all that apply)*

Email College forms Phone Informal face-to-face Formal meetings ProMonitor system

Other ____________

SECTION E

This section is about yourself and mathematics.

		Strongly disagree	Disagree	Neither agree nor	Agree	Strongly agree
Q18	**How do you feel about your own experience of maths?**					
	Maths is a subject that I liked at primary school	1	2	3	4	5
	Maths is a subject that I liked at secondary school	1	2	3	4	5
	Maths is a subject that I like today	1	2	3	4	5
	The maths I learned at school has been useful in my personal life	1	2	3	4	5
	The maths I learned at school has been useful in my career	1	2	3	4	5

Q19 What is the highest qualification in maths that you passed at school? *(please circle, or state alternative)*

GCSE O level CSE A level AS level Other (please state) _______________________

Q20 What maths have you studied or additional maths qualifications have you achieved since school if any?

____

Thank you for taking part in this questionnaire. If you have any further comments then you are welcome to add these below.

1.3 Interview questions for functional mathematics teachers

Yourself

1. Could you explain something about yourself and how you came to be a functional mathematics teacher?
    - What led you towards teaching the subject? Was it your original teaching subject?
    - How did your **own experience of maths** influence you? What **interests** you in teaching the subject?
    - What **training** have you had in teaching functional maths?

2. Could you explain what your role involves this year in the college?
    - What teaching and sort of **timetable** do you have? What balance of **subjects**?
    - What **vocational areas** do you work with? What groups? What **levels**?
    - How do you feel about your **role and status** in the college as a functional maths teacher?

The students

3. Could you tell me about the students that you teach, e.g. their **abilities, attitudes, expectations**?
    - Is functional maths **important** to them? How?
    - What **value** does it have for them?
    - Is it **relevant** to them? How? (e.g. to their personal life, career, progression, current course)
    - What are the **main influences** on these students? (Inside and outside college)
    - What **influence** do you have **over their attitudes** to functional maths? What other influences are there?
    - What are **your expectations** of your students? Will they achieve? Will they improve?
    - What are the main **challenges** or problems for them in learning functional maths?

Your teaching

4. I would like to focus now on what happens in your functional maths sessions and I want to explore three areas: teaching approaches to functional maths, student participation and the outcomes for students.

    Firstly can you tell me how you approach teaching functional maths?
    - Do you teach **problem-solving** in your sessions? If so, how?
    - How much does the functional mathematics **curriculum** influence your teaching? How?
    - How much influence do the tests or **assessments** have on your teaching? How?
    - What are the main **challenges for you** as a teacher? (Curriculum, assessments, students, different from GCSE)

    Secondly, how do you get the students **engaged**? **Motivate** them? **Encourage** them? Get them to **participate**?

- How do you make functional mathematics **relevant** to the students?

Thirdly, what do you feel the **students gain** from the sessions? **Confidence, enjoyment, skills**?

The organisation of functional maths in the college

5. I am interested in understanding how functional mathematics is organised in the college so could you explain this to me, as you understand it?
    - Who **makes the decisions** about functional maths **policy** and **teaching**?
    - Who decides **which students** take functional maths? Who does the **timetables**?
    - In **your opinion**, which students should be doing functional maths? Why? What about **GCSE** instead?

6. What is the **relationship** between functional mathematics teachers and vocational teachers?
    - What **contact** do you have with the vocational teachers? When do you see them?
    - In what ways do the maths team and the vocational teams **work together**? (practical arrangements, content of maths sessions, integrated projects, embedded functional maths)

1.4 Interview questions for vocational teachers

Yourself

1. Could you explain something about yourself and how you came to be a vocational tutor in Further Education?
    - What is your main area of **interest**?
    - What led you towards **teaching**?
    - What **work experience** or **life experience** did you have before teaching?

2. Could you explain what your role involves this year in the college?
    - What teaching and sort of **timetable** do you have? What **subjects**? What **levels**?
    - How do you feel about your **role and status** in the college as a vocational teacher?

The students

3. Could you tell me about the students that you teach, e.g. their **abilities, attitudes, expectations**?
    - Are they well **motivated**? What motivates them?
    - Do they get **engaged** with the vocational course? What interests them?
    - Do they prefer practical or theory sessions?
    - What are your **expectations** of your students? Will they achieve? Will they improve?
    - What teaching approaches do you think work for them?
    - What are the **main influences** on these students? (Inside and outside college)
    - What **influence** do you have over their **attitudes**? What other influences are there?

Functional Maths

4. My particular interest is in functional maths and I'm interested to know what the term functional maths might mean to you?
    - How has maths featured in your **life** so far?
    - Have you ever used maths in a **job**?
    - Is it a subject you **like** or dislike?

5. How do you think students feel about functional maths?
    - What attitudes do they have towards the subject?
    - Is functional maths **important** to them? How?
    - What **value** does it have for them? What **use** is it to them?
    - Is it **relevant** to them? How? (e.g. to their personal life, career, progression, current course)
    - What are the main **challenges** or problems for them in learning functional maths?

The organisation of functional maths in the college

6. I am interested in understanding how functional mathematics is organised in the college so could you explain how this works, from your position, and how you fit into it?
    - Who makes the **decisions** about functional maths **policy**?
    - Who decides **which students** take functional maths? Who does the **timetables**?
    - In **your opinion**, which students should be doing functional maths? Why? What about **GCSE** instead?

7. What is the **relationship** between functional mathematics teachers and vocational teachers?
    - What **contact** do you have with the functional maths teachers?
    - In what ways do the functional maths teachers and the vocational teams **work together**? (practical arrangements, content of maths sessions, integrated projects, embedded functional maths).

1.5 Questions for student focus groups (Term 1)

1. **Why do you think students come to college rather than stay at school?**
   - Do students make their own choices?
   - Do others influence them? If so, who?
   - Are they interested in the courses they choose?

2. **What do students expect to get out of college?**
   - Is it qualifications, skills, friends, a route to further training or employment?

3. **What would you say are the best things about college for students? What are the worst things?**
   - Is college different from school? (Timetable, flexibility, course, teachers)
   - How do you get on with the staff, other students, the course?
   - Has it been easy to adjust to college?

4. **What is maths at school like?**
   - What qualifications did you achieve? How did you feel about maths in school?

5. **What are functional maths sessions like in college**?
   - How do the sessions compare to maths lessons at school?
   - Is the actual maths any different or is it the same?
   - How do you feel about maths now compared to how you felt at school?
   - What do you actually do in the sessions? (student activities, teacher instruction, types of task, group or individual work, participation, learning outcomes)

6. **What use is functional maths to students?**
   - Will it help in the future? How? Is it helpful in life?
   - Does it help students with their vocational course?
   - Are the actual maths skills useful or just the qualification?

7. **Should students take functional maths? Why do you think that?**
   - Why do students take functional maths?
   - Do they have a choice? If not, when do they find out they are taking maths?
   - Would you be doing it if you had the choice? Why?

1.6 Questions for student focus groups (Term 2)

Firstly I want to talk about some tasks that you have not actually done in your functional maths lessons. I'm interested in what seems to be useful, interesting or relevant about these tasks. (Show first task and ask questions then follow with second and third tasks)

1. **What are your impressions of this task?**
    - Is there anything that interests you in this task or not? Why is it interesting (or not interesting)?
    - Would the task be difficult or easy for you? Can you explain why?
    - Would you enjoy doing this task or not? Why?

2. **Would you say the task was relevant to you in any way?**
    - Is the task about a situation that would occur in real life or not?
    - Is it about a situation you have actually experienced or not?
    - Is it something you might experience in the future?
    - Does it relate to your vocational area or not? If so, how?
    - Is the task about a situation that would occur at work or not?
    - Would you actually do this task in the workplace in the future?

3. **What useful skills or knowledge would you gain through doing this task?**
    - Would you gain skills or knowledge that would be useful for passing the exam?
    - Would you gain skills or knowledge that would be useful for other purposes?
    - Would the skills or knowledge be useful in real life?
    - Would the skills or knowledge be useful at work?

Secondly I'd like you to think back over the work you have done in functional maths this year and about the tasks or activities that you have been given.

4. **During this year can you remember any tasks or activities in functional maths that were particularly interesting or useful?**
    - Why were these tasks or activities interesting or useful?
    - Did they relate to your life, vocational course, personal interests?
    - What has been the best thing you have done this year in functional maths? Why?

1.7 Questions for student focus groups (Term 3)

I have already talked to you about your experience of functional maths in college and some of these questions may be similar to questions I have asked before but I am interested to see how you feel now at the end of the year and whether your opinions have changed at all.

1. **Overall what would you say you had gained from your functional maths course, if anything?**

- Have you learned any new maths? If so, what was it?
- Was the functional maths different from the maths you learned at school or the same?
- Have you got better with any aspect of maths during the course? If so, in what way?
- Has the course helped you revise or refresh your knowledge of maths?
- Have you taken a qualification yet? If not when will you be taking the exam?
- Have any of you already passed a qualification this year? If so, will you be taking another qualification? Are you still required to attend? (*May not be appropriate for some groups where it is a sensitive issue*)

2. **Has the functional maths course been useful to you in any way?**

- Do you feel that you needed to do a functional maths course? Has it met any needs you had?
- Has it related or connected to your life in any way?
- Has the functional maths been useful to you during the year? For your vocational course or personal life?
- Has it prepared you for the future in any way?
- Do you think you will use any functional maths skills in the future? If so where or how?
- Will your functional maths qualification be useful to you? Do you need the qualification to progress to the next level in college or could you have done that anyway? Do you need it for your career?

3. **How do you feel now about the experience of doing a functional maths course?**

- Do you feel it has it been a good use of your time? Why or why not?
- What have been the best and worst parts for you?
- Have you enjoyed any part of the course?
- Has any part of the course been interesting?
- Do you feel any more confident about maths or not?
- Do you feel any different compared to when you started?
- Is your attitude now more positive or negative towards maths?
- For those who have already passed a qualification, how did you feel when you got the result?

4. **Is there anything that would have made the experience of learning functional maths better for you?**

1.8 Tasks used with student focus groups (Term 2)

Task	HA1	HA2	HB1	HB2	HC1	HC2	CA1	CA2	CB1	CB2	CC1	CC2	PA1	PA2	PB1	PB2	PC1
Colouring hair	✔	✔	×	×	✔												
Making a salon schedule	×	×	✔	✔	✔	✔											
Cashing up	✔	✔	✔		✔	✔											
Designing a salon	×	×	✔	✔		✔											
Shifting loads							✔	✔	✔	✔	×	×	✔				
Fitting a kitchen							✔	✔	✔	×	✔	✔					✔
Building a fence							✔	✔	✔	✔	✔	✔					
Alcohol awareness	✔									✔			×	✔	✔	✔	✔
Planning a holiday		✔									✔	✔	✔	✔	✔	✔	
Choosing an MP3 player	×	×		✔									✔	✔	✔	✔	✔

× = task already familiar to group

Coding example: HA1 = Hair and Beauty, College A, Group 1

H = Hair and Beauty, C = Construction, P = Public Services.

1.9 Samples of tasks used with student focus groups (Term 2)

Example 1: Colouring hair

Data sheet **Hair salon**

At ***Headlines*** hair salon one of the treatments available is hair colouring.
For hair colouring the hairdresser puts a rinse on the clients hair.
The amount of colour needed depends on the length of hair.
This is shown in the first table.

Amount of colour mixture needed

Hair length	Millilitres (ml) of colour mixture needed
Very short	20
Short	30
Medium	40
Long	50
Very long	60

The mixture for the rinse consists of the colours and the proportions shown in the table below

		Main colours			
		Black	**Brown**	**Red**	**Blonde**
Colour required by client	**Black rinse**	1			
	Dark brown rinse	3/4	1/4		
	Brown rinse		1		
	Auburn rinse		1/2	1/2	
	Red rinse			1	
	Copper rinse		1/4	1/2	[illegible] 1/4
	Light brown rinse		1/2		1/2
	Blonde rinse				1

Questions Hair Salon

1
Shirley has long hair.
She wants a brown rinse on her hair.
How many millilitres of brown colour does the hairdresser need to use?

______________ ml

2
Paul has very short hair.
He wants blonde highlights.
This uses half of the usual volume of colour.
How many millilitres of blonde colour does the hairdresser need to use?

______________ml

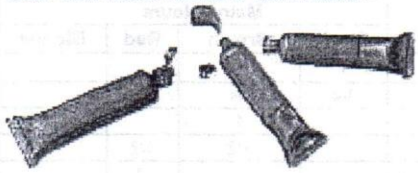
3
Hafifa is having a copper rinse on her hair. She has medium length hair.
How many millilitres of each colour does the hairdresser need to mix?

Brown ______________ml

Red ______________ml

Blonde ______________ml

4
Each main colour comes in 100ml tubes.



Jane has medium length hair.
She wants a brown rinse put on her hair.
What fraction of a brown tube is needed? Give your answer in its simplest form.

5
Monica has very short hair.
She wants a dark brown rinse on her hair.
What fraction of each tube does the hairdresser need to use? Give your answer in its simplest form.

Example 2: Buying an MP3 player

MP3 Player

The memory of an MP3 player is measured in gigabytes (GB).
1 gigabyte ≈ 1000 megabytes (≈ means approximately equal to)

Here is some information about MP3 players.

Model	NWZ-B135B	NWZ-E436FB	NWZ-S638FB	NWZ-S639FB
Price	£34.00	£68.50	£87.50	£117.00
Memory size	2GB	4GB	8GB	16GB
Battery life	Up to 16 hours music	45 hours music 8 hours video	40 hours music 10 hours video	40 hours music 10 hours video
Dimensions (mm) (L × W × H)	89.5 × 25 × 15	83.9 × 44 × 8.5	89.5 × 42.9 × 7.5	89.5 × 42.9 × 7.5
Radio	No	Yes	Yes	Yes
Weight	29g	50g	46g	46g

You might listen to the radio on the MP3 player, but you don't think you will use it for video.

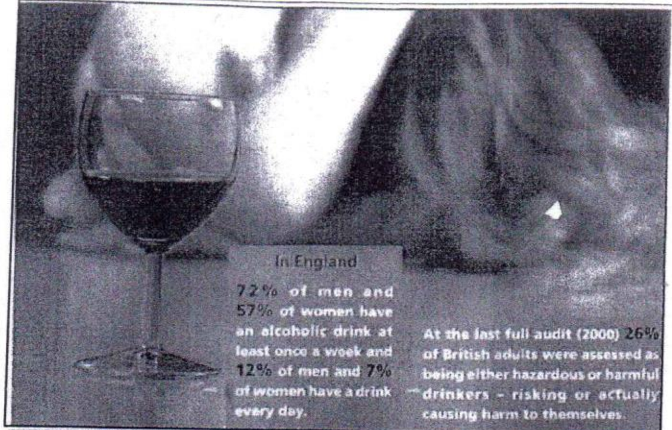
You want to buy a player with enough memory to store the tracks you already have. You estimate that every week you download about 4 new tracks that you will also want to add to your MP3 player.

(c) Which MP3 player do you think would be best for your needs?
You need to consider what storage you need now and what you will need for tracks you add in the future.
Explain how you reach your decision.

Example 3: Alcohol awareness

Name...Date..................................

Alcohol Awareness Week 19th – 23rd November 2012



The adult population of England is: 18, 984, 000 males
20, 098, 000 females

Use the article above to answer the following questions:

(a) Round the number of males and females in England to the nearest million:

(i) Males = ... [1 mark]

(ii) Females = ... [1 mark]

(b) Use your rounded values to [3 marks]

(i) calculate the **fraction** of males in England

(ii) calculate the **percentage** of males in England

(iii) calculate the **percentage** of females in England

(c) What fraction of men has alcohol at least **once a week**?
Express this fraction is its simplest terms [2 marks]

(d) How many men have alcohol **once a week**? Give your answer to the nearest hundred thousand [2 marks]

....

(e) What **fraction** of women has alcohol every day? [1 mark]

(i)How many women have a drink every day? [1 mark]

The adult population of Britain is: Males = 23 million and Females = 24 million

(g) What is the total number of adults in Britain? [1 mark]

(h) How **many** British adults are either hazardous or harmful drinkers? [2 marks]

http://www.statistics.gov.uk/downloads/theme_compendia/AA2010/aa2010final.pdf

Mathematics (level 1) Level 2 *understand and use the equivalences between (common) fraction, decimals and percentages*

Example 4: Cashing up

Skillswise

Level 1 J

Handling cash in hair and beauty

Task 1: Total up the value of the notes and add the amount to the pounds and pence column.

Task 2: Calculate the total in till and write it in.

Task 3: Calculate the cash takings for the day.

Hair today - cashing up (end of day)			
Coin/note value	**Number of coins/notes**	**£**	**p**
£20	7		
£10	9		
£5	16		
£2		**22**	**00**
£1		**24**	**00**
50p		**7**	**50**
20p		**7**	**20**
10p		**9**	**80**
5p		**4**	**25**
2p		**0**	**66**
1p		**0**	**44**
TOTAL in till			
Less float		**50**	**00**
CASH TAKINGS			

bbc.co.uk/skillswise

APPENDIX 2: Data collection and case study groups

2.1 Initial summary of case study groups

Vocational Area	Level of voc. course	Code	College	Host Department	Site	Teacher				Vocational Area			Policy A = All group S = Selected on basis of GCSE result
						Name	Gender	Team C= central D= dispersed V=vocational	Teacher background before teaching	Gender bias of group	Strong links to maths	Main focus T = theory P =practical	
Hairdressing	2	HA1	A	Hair & Beauty	A4	Richard	M	D	Army	F	No	P	S
Hairdressing	2	HA2	A	Hair & Beauty	A2	Richard	M	D	(Army)	F	No	P	S
Hairdressing	2	HB1	B	Hair & Beauty	B1	Vince	M	D	Finance	F	No	P	A
Hairdressing	2	HB2	B	Hair & Beauty	B1	Vince	M	D	(Finance)	F	No	P	A
Hairdressing	2	HC1	C	Hair & Beauty	C1	Kathy	F	C	Medical Physics	F	No	P	A
Beauty Therapy	2	HC2	C	Hair & Beauty	C1	Keith	M	D	Outdoor Pursuits	F	No	P	S
Electrical Installation	2	CA1	A	Construction	A4	Ian	M	C	Engineering	M	Yes	P	A
Plumbing	2	CA2	A	Construction	A4	Chris	M	D	Engineering	M	Yes	P	A
Electrical Installation	2	CB1	B	Electrical Engineering	B1	Rachel	F	D	Chemistry then Journalism	M	Yes	P	A
Carpentry and Joinery	2	CB2	B	Construction	B1	Linda	F	D	Retail	M	Yes	P	A
Plumbing and Heating	1	CC1	C	Construction	C2	Elliott	M	D	Electrician	M	Yes	P	A
Construction Trades	1	CC2	C	Construction	C2	Elliott	M	D	(Electrician)	M	Yes	P	A
Public Services	2	PA1	A	Public Services	A1	Lindsay	F	C	Retail	M	No	T	A
Forensics	2	PA2	A	Science	A1	Edwin	M	V	Police	Mixed	Yes	T	S
Public Services	3	PB1	B	Public Services	B1/B2	Dan	M	C	IT	M	No	T	A
Emergency Care	2	PB2	B	Public Services	B1	Dan	M	D	(IT)	Mixed	No	T	S
Public Services	2	PC1	C	Public Services	C1/C2	David	M	D	Engineering	M	No	T	A

2.2 Proposed plan for data collection (two colleges)

Phase	Method	Number per college	Total	July 2012	Aug 2012	Sept 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013	Feb 2013	Mar 2013	Apr 2013	May 2013	June 2013
1	**Interviews with managers**	1	2	2											
	Questionnaires for functional maths teachers	All functional maths teachers	30-100	30-100											
2	**Student focus groups**	6 groups. Each 3 times in the year	36				6	6		6	6		6	6	
	Interviews with functional maths staff	6 staff. One interview each	12				6	6							
	Observations of student groups in functional mathematics lessons	6 obs. One per group.	12						6			6			
3	**Questionnaires for vocational staff**	Two vocational teams	20-30					20-30							
	Interviews with vocational staff	3-5 staff. One interview each	8-10						4	6					

2.3 Implemented plan for data collection (three colleges)

hase	Method	Planned number (2 colleges)	Total completed (3 colleges)	July 2012	Aug 2012	Sept 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013	Feb 2013	Mar 2013	Apr 2013	May 2013	June 2013
1	**Interviews with managers**	2	3	2			1								
	Questionnaires for functional maths teachers	30-100	39	A			B and C								
2	**Student focus groups**	36	17					4	7	4	2				
			17									14	1	2	
			17											13	4
	Interviews with functional maths staff	12	20			1	5	8	5	1					
	Observations of student groups in functional mathematics lessons	12	34				2	8	13	10	1				
			31							4	13	14			
	Observations of students in vocational sessions	12	17								9	6		2	
3	**Questionnaires for vocational staff**	20-30	38									12 vocational teams			
	Interviews with vocational tutors	8-12	14								3	10			1

2.4 Summary of main features of case study groups

Teacher	Group code	Vocational area	General response to FM lessons	Mature students in class	Students with GCSE C	Dominant concept of FM	Context most used	Teacher and student relationships	Team	Distinguishing features re relevance, motivation and engagement
Richard	HA1	Hairdressing	Mixed	Y	N	Tool for life	Vocational	Mostly positive	Dispersed	Uses vocational area with some success.
Richard	HA2	Hairdressing	Mixed	Y	N	Tool for life	Vocational	Mostly negative	Dispersed	Uses vocational area with some success.
Vince	HB1	Hairdressing	Mixed	Y	N	Unclear	Vocational	Mostly positive	Dispersed	Tries variety of methods and materials with some effect.
Vince	HB2	Hairdressing	Negative	N	N	Unclear	Vocational	Negative	Dispersed	Tries variety of methods and materials with little effect.
Elizabeth	HC1	Hairdressing	Negative	N	N	Basic maths	Not vocational	Negative	Central	Apprentices. Need to pass exam. Workshop attendance.
Keith	HC2	Beauty Therapy	Positive	N	N	Tool for life	Mixed	Positive	Dispersed	Uses discussion and a variety of contexts to convince students.
Ian	CA1	Construction (Electrical Installation)	Positive	Y	Y	Tool for life	Mixed	Mostly positive	Central	Teaches maths relevant to electrical course in FM.
Chris	CA2	Construction (Plumbing)	Negative	Y	Y	Tool for life	Vocational	Mostly negative	Dispersed	Uses examples of relevant maths but little interaction/discussion.
Rachel	CB1	Construction (Electrical Installation)	Negative	N	Y	Problem-solving	Not vocational	Mostly positive	Dispersed	Uses logic problems and contexts that do not relate to electrical.
Linda	CB2	Construction (Carp and Joinery)	Mixed	N	Y	Tool for life	Vocational	Mostly positive	Dispersed	Uses vocational area with some success.
Elliott	CC1	Construction (Plumbing and Heating)	Mixed	N	Y	Tool for life	Vocational	Mostly positive	Dispersed	Uses vocational area creatively with some positive effects.
Elliott	CC2	Construction (Construction trades)	Positive	Y	Y	Tool for life	Vocational	Mostly positive	Dispersed	Uses vocational area creatively with some positive effects.
Lindsay	PA1	Public Services	Positive	N	Y	Tool for life	Personal interest	Positive	Central	Uses discussion and issues of interest to make FM relevant.
Edwin	PA2	Forensics	Positive	Y	N	Tool for life	Vocational	Positive	Dispersed	Uses voc area. Explains using different methods to individuals.
Dan	PB1	Public Services	Mixed	N	Y	Tool for life	Personal interest	Mostly positive	Dispersed	Relevant because need FM to enter armed forces.
Dan	PB2	Public Services (Emergency Care)	Mixed	N	N	Tool for life	Personal interest	Mostly positive	Dispersed	Tries to use topics of interest to students but effect varies.
David	PC1	Public Services	Negative	N	Y	Basic maths	Personal interest	Negative	Central	Tries to use topics of interest but unauthentic and ineffective.

APPENDIX 3: Results and analysis

3.1 Questionnaire summary for functional mathematics teachers

Employment and gender					
Male	22	**Female**	17		
Full-time	28	**Part-time**	11		
Permanent	33	**Temporary**	4	**Mixed contracts**	2

Teaching experience	
Mean length of service as a teacher (years)	10.7
Mean length of service in current college (years)	7.2
Number of teachers with experience exclusive to current college	21

SD = strongly disagree, D = disagree, N = neither, A = agree, SA = strongly agree.

STATEMENT	SD	D	N	A	SA
Functional maths is the same as basic numeracy	21	9	4	2	0
Functional maths involves real life applications	0	0	0	12	26
Functional maths is about developing problem-solving skills	1	0	0	13	24
Functional maths requires reasoning and thinking skills	0	0	1	13	24
Functional maths is similar to GCSE	5	18	14	1	0
Functional maths is needed for real life	0	0	0	17	21
Functional maths is the maths needed for the workplace	0	0	3	16	19
Functional maths skills are transferable to different situations	0	0	0	15	23
Students find functional maths relevant to their current life experience	0	10	8	13	6
Functional maths skill help students with their vocational course	0	2	4	23	8
Students will use the skills they learn in their personal lives in the future	0	1	1	16	19
The skills they learn in functional maths will be useful in the workplace	0	0	0	19	17
A functional maths qualification will help students gain employment	0	3	9	16	8
Students gain confidence from passing a functional maths qualification	0	0	3	19	15
Students need the qualification to progress to the next vocational course	3	2	8	16	8
Students will progress further in their careers with the qualification	1	1	14	14	7
Students enjoy functional maths	3	9	11	12	1
Students want to succeed with functional maths	0	5	16	15	1
Students are interested in functional maths	2	12	13	9	1

Students develop confidence in functional maths sessions	0	3	3	25	6
Learning functional maths is a positive experience for students	1	2	13	17	4
Students work individually on written tasks or questions	1	18	9	8	1
Students work collaboratively in pairs or small groups	0	19	9	9	1
I explain the topic before students attempt the questions	0	4	2	7	23
Students discuss and explain their ideas to each other	0	13	7	14	2
The students practise once I have taught them the methods	1	4	5	14	14
Students do work on their own using worksheets or textbooks	3	19	3	9	4
Students work individually using computers	17	14	2	2	3
Students get involved in discussions and ask questions	0	7	6	19	6
Students work on tasks that require problem-solving approaches	0	3	5	15	15
I break down problems into simple steps for students	0	7	6	14	11
Students explain their own ideas about how to solve a problem	1	11	6	18	2
I teach students strategies for solving problems	0	5	5	18	10
I test students' understanding with simple closed questions	8	17	5	5	3
Students do tasks that develop their reasoning and thinking skills	0	5	11	18	4
Students practice on developing their basic numeracy skills	3	14	11	5	5
I use open-ended questions with students	0	8	9	11	8
I use scenarios and problems that would occur in real life	0	1	1	15	21
The maths we do is linked to the students' vocational course	1	15	10	9	3
Students do tasks in a work-related context	2	13	8	13	2
The context used would relate to the interests of most students	1	13	8	13	2
I use scenarios relevant to the students' current lives	0	11	9	13	5
Students do tasks set in a vocational context relevant to them	2	17	6	11	2
Students practice skills that do not require a context	6	17	13	2	0
Students do similar tasks to ones that occur in the workplace	0	17	9	10	2
We work together to develop maths tasks for students	5	12	7	6	4
I have a good working relationship with the vocational staff	0	1	3	16	13
We regularly discuss students and their progress together	0	3	6	9	15
There is tension between vocational staff and functional maths staff	16	9	6	2	0

3.3 Summary of student responses to individual activities

QUESTION A: I came to this college because…									
Rank given	**Score (S)**	**Frequency (f)**							
		My friends were coming here	My brother or sister came here	My parents wanted me to come	I wanted to get away from school	I liked it when I came to visit	I thought the college was more adult	I was interested in the course	I wanted to improve my education
1	5	1	2	9	5	2	3	56	23
2	4	2	0	5	12	9	5	33	34
3	3	4	2	12	4	18	9	7	13
4	2	8	2	5	2	7	5	2	4
5	2	5	1	1	5	0	4	0	2
Σ (S × f)		46	21	112	94	114	76	437	300

SA = strongly agree, A = agree, N = neither, D = disagree, SD = strongly disagree

QUESTION B: What is college like? (compared to school)					
STATEMENT	SA	A	N	D	SD
There is more freedom than there is in school	45	42	9	6	1
It has been easy to make friends	32	48	23	0	0
I get on with the staff in college	25	58	16	4	0
You are treated better at college than school	26	50	21	6	0
College work is easier than school	8	32	38	21	4
The staff treat you like adults	23	51	15	10	2
My course is interesting	47	44	8	2	1
I like the subjects I do	32	57	10	4	0

QUESTION C: Functional mathematics is important to me because…					
STATEMENT	SA	A	N	D	SD
I need the qualification to progress	44	39	13	4	1
It helps me with my main course	18	46	26	9	3
I will need to use maths in a job one day	47	46	8	1	0
I want to get a better qualification in maths	35	38	26	3	1
I will need maths to get a job	31	41	19	6	2
The skills are useful	26	60	15	1	0
The maths is related to life	22	52	21	8	0
Maths is a subject you need to get on in life	53	41	7	2	0
The maths is linked to my main course	15	55	26	6	0
The maths is related to life	34	40	24	3	0

AA = almost always, S = sometimes, H = about half the time, O = occasionally, AN = almost never

QUESTION D: When you did maths at school how did you feel?					
STATEMENT	AA	S	H	O	AN
I worked hard	13	34	31	14	9
It was difficult	9	29	28	28	8
I got distracted	22	31	16	29	4
I liked maths	9	20	14	20	38
I felt stressed	15	20	19	29	19
I was bored	21	20	26	27	7
I liked the teacher	11	23	19	13	36
I felt confident	4	22	21	38	17
It was interesting	2	14	18	34	34
I understood it	6	30	27	24	15
It was confusing	14	21	23	38	6
I could have done better	34	30	17	19	0

QUESTION E: How do you feel about functional maths now?					
STATEMENT	AA	S	H	O	AN
I work hard	19	41	22	17	4
It is difficult	7	13	18	49	16
I get distracted	12	19	23	33	16
I like maths	7	20	35	26	15
I feel stressed	6	10	12	34	39
I am bored	8	13	24	48	9
I like the teacher	40	31	13	12	7
I feel confident	6	37	32	16	12
It is interesting	3	23	38	26	13
I understand it	13	45	21	18	5
It is confusing	10	11	20	49	11
I could do better	16	28	34	19	6

QUESTION F: In my functional maths lessons in college…					
STATEMENT	AA	S	H	O	AN
We learn to solve problems	25	40	27	9	2
We get help if we don't understand	52	36	8	5	2
We do exercises on our basic number skills	15	29	30	24	5
I learn from talking to other students	14	30	22	27	10
We are shown what to do then we practise	28	44	15	11	3
We work together as a class on a question	19	25	20	28	10
We practise exam questions	9	15	21	32	25
We talk in groups about our ideas	15	28	22	23	15
The teacher gives clear explanations	29	44	11	11	8
We work on our own	16	36	27	16	8

STUDENT PROFILES	
Male	**Female**
56	47

GCSE GRADES					
A	**B**	**C**	**D**	**E**	**F**
1	6	30	21	17	3

OTHER MATHEMATICS QUALIFICATIONS							
FM E3	**FM L1**	**FM L2**	**AN E3**	**AN L1**	**AN L2**	**AoN L1**	**AoN L2**
9	6	1	0	1	3	0	1

FM = functional mathematics

AN = Adult Numeracy

AoN = Key Skills Application of Number

3.3 Analysis of student responses to individual activity (Term 1)

Table 1 shows the differences between school and college in individual student ratings of statements (numerical score = college – school)
Table 2 shows a summary of these differences, the z values for the sign test and the conclusions reached.

Table 1											Statement	Table 2					
-5	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**		negative	no change	positive	z value	significance	Conclusions
0	1	2	4	18	36	28	10	2	1	0	I worked hard	25	36	41	-1.846	not sig.	
0	0	4	22	29	28	16	3	1	0	0	It was difficult	55	28	20	-3.926	**sig. at 1%**	**less difficult in college**
0	1	8	20	25	29	12	6	1	1	0	I got distracted	54	29	20	-3.836	**sig. at 1%**	**less distracted in college**
1	1	2	4	15	39	22	12	5	2	0	I liked maths	23	39	41	-2.125	sig. at 5%	more liked in college
0	2	9	16	28	33	9	4	1	1	0	I felt stressed	55	33	15	-4.661	**sig. at 1%**	**less stressed in college**
0	4	8	20	18	26	17	7	1	2	0	I was bored	50	26	27	-2.507	sig. at 5%	less bored in college
0	1	3	4	9	22	16	18	18	12	0	I liked the teacher	17	22	64	-5.111	**sig. at 1%**	**more liked in college**
1	0	1	2	9	47	21	15	7	0	0	I felt confident	13	47	43	-3.875	**sig. at 1%**	**more confident in college**
1	0	0	4	12	33	27	22	3	1	0	It was interesting	17	33	53	-4.183	**sig. at 1%**	**more interesting in college**
0	0	2	1	11	37	33	14	5	0	0	I understood it	14	37	52	-4.554	**sig. at 1%**	**better understood in college**
0	1	5	12	24	41	13	5	1	0	1	It was confusing	42	41	20	-2.667	**sig. at 1%**	**less confusing in college**
0	2	6	17	26	28	16	6	1	1	0	I could have done better	51	028	24	-3.002	**sig. at 1%**	**less of this feeling in college**