AN EXPLORATORY INVESTIGATION INTO THE CONTEXT SPECIFIC PERCEPTIONS AND PRACTICES OF SECOND YEAR MECHANICAL ENGINEERING UNDERGRADUATES

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Abstract

AN EXPLORATORY INVESTIGATION INTO THE CONTEXT SPECIFIC PERCEPTIONS AND PRACTICES OF SECOND YEAR MECHANICAL ENGINEERING UNDERGRADUATES

This thesis explores students' perceptions and practices within the context of a Mechanical Engineering undergraduate degree at a UK Higher Education institution. This engineering education research is situated in the pragmatic paradigm and is informed by a relational view of learning. The study explores the perceptions of students throughout the second year of their programme and also investigates their practices during the same time period.

The research employs a mixed-methods exploratory methodology with data collection led by a dominant qualitative phase and followed by a quantitative phase. Data is integrated to present a holistic understanding of students' perceptions and practices.

The results demonstrate the importance for academia to consider students' expectations and perceptions and to understand students' actual practices. Analysis of the data has enabled the context to be defined from a student perspective; showing four key areas of context as being the staff-student relationships, students and student cultures, the teaching and assessment context, and the course contexts.

The connection between students' perceptions and their practices is clearly established in the data. The integrated findings highlight the complexities involved for students in carrying out the practice of learning in a complex environment alongside their own perceptions of the discipline, the programme, their peers and staff. Combining the two data types has enabled the significance of perceptions to be highlighted, the vast elements of context to be demonstrated and finally recommendations to be produced to inform the design and execution of engineering education.

Specific attention is drawn to findings which suggest further explanatory work is required to explore aspects such as; students' perceptions of importance, their participation in informal peer working, the distinction between procedural and conceptual learning for the discipline and the expectation of professionalism that students hold.

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My final thanks goes to my husband Mike, our beautiful daughter Eeva, and both our sets of parents. The support of my family has been essential in enabling me to complete this work and I hope I have done, and continue to, make them proud.

Declaration

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas and contributions from the work of others.

Any ethical clearance for the research presented in this thesis has been approved. Approval has been sought, and was granted through the IPA approval process on 23 February 2009.

Name:

Signature:

Date:

1. Introduction

1.1 Background to Engineering Education

The objective of engineering education as defined by Crawley et al. (2010, p.6) is to educate students who are 'ready to engineer,' or in other words, students who are prepared with the professional skills of engineering and are knowledgeable of the technical fundamentals. Those entering a career in engineering have to deal with scientific and technological matters in addition to economical and political matters, and also matters relating to ethics, society and the environment (Maffioli and Augusti, 2003). While Spinks et al. (2006, p.3) recognise that engineers must have a '…sound knowledge of the engineering fundamentals within their discipline, built on a solid base of mathematics,' they agree with Maffioli and Augusti that technological competencies are no longer enough for engineers; they must have a strong knowledge foundation in engineering sciences, have knowledge of technology, be good communicators, have good teamwork skills, business skills and be prepared for lifelong learning.

The subject benchmark statement for engineering (QAA, 2006) in the United Kingdom (UK) details the qualities, skills and attributes that are thought essential to enable the engineer to practice effectively in a professional manner (Maddocks et al., 2002). They are listed in the subject benchmark statement under the five headings of *Knowledge and Understanding, Intellectual Abilities, Practical Skills, General Transferable Skills and Qualities*. Students are expected to 'learn to communicate with others, to become problem-solvers, to become aware of ethical aspects of their professional work, and to prepare for a life of entrepreneurship' (Booth, 2004b, p.10). New ways of working, studying, and collaborating are required to support this (Hammarainen, 2004, cited in Nielsen et al., 2008).

1.2 Engineering Education Research

The field of engineering education research itself is a moderately new field of enquiry (Jesiek et al., 2008) and despite a tradition of innovation in the education of engineers there was limited scholarly appraisal before the 1980's (Wankat et al., 2002).

The study presented in this thesis is an example of research in the emerging field of engineering education. It is part of a developing body of research which focuses on rigorous research in engineering education, aiming to advance the scholarship of the discipline through presentation of well documented and thorough research. As a field of

research, engineering education is interested in teaching and learning within the engineering education field, looking to advance or enhance methods used to produce high quality engineers upon their graduation. Gabriele (2005) suggested that to move forward research in engineering education there should be a particular focus on conducting fundamental research into how students learn engineering.

Rigorous research in engineering education is that which is considered to make a difference in theory and in practice (Streveler and Smith, 2006). It should also be grounded in theory, have appropriate design and methodology, and ensure that implications for teaching are considered.

Notably a large amount of the current and rigorous engineering education research is being advanced by American based research (Wankat et al., 2002). This is largely presumed to be due to the funding support that the National Science Foundation have provided. In the UK, discipline based educational research was progressed with the Learning and Teaching Support Network (which evolved into the Higher Education Academy) and the EngCETL (Engineering Centre of Excellence in Teaching and Learning). The EngCETL allowed for a number of funded research projects and for PhD studentships that focussed on engineering education research (Arlett et al., 2009). More recently, the National HE STEM programme alongside the Royal Academy of Engineering, funded a call for small scale engineering education research projects (National HE STEM Programme, 2013). This thesis adds to the UK and global understanding of engineering education.

1.3 The Discipline of Engineering

The skills required by engineers are often referred to as ‘attributes’ or ‘competencies’. In the UK the Engineering Council publishes the competency standards for engineering in the form of UK SPEC (Engineering Council, 2011). Universities in the UK can have their programmes accredited by professional engineering institutions acting on behalf of the Engineering Council, providing they deliver the learning outcomes which the professional institution has specified. Similarly, in the US, scholarly approaches to teaching and learning are influenced by the fact that programs must set and assess learning objectives which involve both technical and interpersonal skills (Wankat et al., 2002). A guide written for the UK’s Higher Education Academy’s Engineering Subject Centre (Houghton, 2004, p.10) suggests that within engineering education we need to ‘concentrate on the key concepts, not just in isolation, but also by demonstrating the way that the components link together’. Sheppard et al. (2006) propose that engineering practice may be thought of as consisting of three components:- engineering as problem

solving, engineering as knowledge, engineering as integration of process and knowledge.

Barr and Tagg (1995, p.13) identified that engineering education in many colleges and institutes, more or less, still follows the traditional instruction and knowledge delivery approach and generally is referred to as the 'instruction paradigm'. In 1999, Cole considered that engineering material was taught the same way it had been for decades 'using lectures, homework assignments, and laboratory experiments, all based upon using mathematical models to represent physical phenomena.' More recently Maffioli and Augusti (2003) identified that there can be quite substantial differences between universities in the style of teaching and learning within engineering. With this in mind however, Covill et al. (2007) do clarify that engineering is commonly presented in a modular format; individual subject-based modules taught are often isolated and independent from one another, with one major project at the end of the degree. Felder and Brent (2005, p.57) identify a short-fall in the education of engineers recognising that academics do complain that engineering students '... can memorize and plug numbers into formulas but they don't know how to think!'

Recognising that some individuals do learn well in traditional engineering learning environments, Moos (2002, cited in Kellam and Gattie, 2008) suggests that this should not be assumed to be acceptable for all. Felder and Brent (2005) recognise that while a one-size-fits-all approach cannot meet the needs of every student, it is also impractical to tailor instruction to each individual; a more balanced approach is needed. The author here agrees that in moving engineering education forward academics need to look at what is most beneficial to the students; the appropriate balance for the specific learning context is needed. Finding that balance should be done in line with Crawley et al. (2010, p.10) questions for engineering education, asking: 'what is the full set of knowledge, skills, and attitudes that engineering students should posses as they leave the university, and at what level of proficiency?' and also 'how can we do better at ensuring that students learn these skills?'

1.4 Teaching and Learning in Engineering

In this research, higher quality student learning is considered through Entwistle's (2008, p.4) definition that 'high quality learning depends not just on pass or completion rates, but on the nature of the knowledge, skills and conceptual understanding that students have acquired during their degree course'. Fordyce's (1986, p.240) definition of engineering education ties in closely with this; he emphasises that engineering education is concerned with 'the development of the quality of thinking of students.'

Generic teaching and learning research has shown that students' approaches to learning are related to the quality of their learning outcomes (Ellis et al., 2008). The terms *deep learning* and *surface learning* are used to describe the qualitatively different levels of processes or approaches that students take to learning situations (Marton and Saljo, 2005). Prosser and Trigwell (2001) suggest that students who adopt a surface approach to learning are more likely to achieve low quality learning outcomes in contrast to those who adopt deep approaches (and are likely to attain higher quality learning outcomes). Laird et al. (2008) report that surface learning does tend to dominate in engineering.

Taylor & Hyde (2000) discuss how research has shown a number of relationships linking the quality of learning outcomes to concepts of learning, approaches to learning and perceptions of teaching and learning. They explain that students' perception of context influences their approaches to learning and their learning outcomes. In engineering education research the concept of the *context of teaching and learning* is one which must be addressed. (Tessmer and Richey, 1997, p.87) explain that 'context is not the additive influence of discrete entities but rather the simultaneous interaction of a number of mutually influential factors'. They describe context as 'an element that surrounds its members as a continuous presence' and discuss how contextual elements can be engineered to facilitate learning and performance. The complex nature of education means that no aspect of the context can be considered in isolation; to be thorough, investigations in engineering education must consider the whole context.

Ellis et al. (2008) cites the work of Goodyear et al. (2005) and Struyven et al. (2006) to conclude that how students interpret and experience a course is more important than the course's underlying pedagogical intentions. Entwistle (2009) carried out teaching and learning research in electrical engineering and concluded that 'it is not so much the teaching-learning environment we provide that affects the learning approaches of individual learners, as their perceptions of it.' This informs the decision to explore students' perceptions within this thesis.

1.5 Research Question

Ellis et al. (2008) discuss that research on student learning in higher education (HE) tends to partition the factors that relate to learning outcomes into two sets: student factors and teaching/environmental factors. This work asserts that (based on the definitions of context) student, teaching and environmental factors cannot be so neatly separated. It is also accepted that it is not possible to influence all aspects of student learning situations and experiences; this research therefore aims to investigate students'

perceptions and their learning practices in response to teaching and environmental contexts.

This work examines student perceptions and learning practices at an intermediate stage of their course; a point of study which is reported far less than early stages of courses (a number of studies focus on first year factors or course exit points). Ultimately, if academics can understand how students perceive the teaching and learning environment and how they approach their studies, then universities can consider making appropriate changes to further improve the teaching and learning in engineering.

The research question is defined as:

> "How do contextual factors influence the approaches, and perceptions of, undergraduate mechanical engineers?"

Following explanation of the associated literature in Chapter 2, it is hoped that the reader will appreciate the theoretical framework influencing this research. To identify how contextual factors affect students perception of, and approaches to learning in engineering programmes, the following theories and the related literature will be used; Approaches to Learning, Perceptions of Learning, Contextual Factors influencing Learning, Ways of Thinking and Practicing, and the Inner Logic of the Subject. Additional literature will be explored as appropriate.

1.6 Research Aims and Objectives

1.6.1 Research Aims

This research project focuses on identification of the contextual factors that most affect a cohort's perception of, and their approaches towards, learning in a mechanical engineering programme.

The aim of this research project is to identify how students perceive their teaching and learning environment, considering what contextual factors influence the students' perceptions of the programme.

The research then aims to identify how the contextual factors influence the students in their approaches to learning and their learning practices.

This thesis aims to highlight the importance of considering students' perceptions of, and approaches to, undergraduate mechanical engineering education. Whilst considering course delivery techniques for engineering students, it is also proposed that understanding how students perceive their learning contexts at university is vital. It is

essential that academics understand how these perceptions influence students' approaches to their studies. The thesis builds on existing research which considers the relationships linking quality of learning with approaches to, and perceptions of, teaching and learning.

The research project discussed in this thesis describes the use of a mixed methods exploratory research methodology to investigate the complex nature of students' perceptions and approaches within engineering. An additional aim of this research is to consider mixed methods research and its suitability as a methodology for engineering education researchers to adopt.

1.6.2 Objectives of this Research

The research looks at identifying the factors which may improve students' perceptions and approaches to learning, making the assumption that this will enable some of the barriers towards learning to be removed and to promote higher quality learning. The objectives outlined below are intended to be specific measureable targets for this research.

- Understand current status of engineering education research
- Use qualitative data to explore the perceptions, practices and approaches to learning of mechanical engineering students in a particular case
- Develop a quantitative instrument based on qualitative findings
- Use instrument to collect quantitative data to further explore the qualitative data
- Combine the two data types to fully understand how students perceive their teaching and learning context and also what practice and approaches they use within their learning
- Evaluate the use of the mixed methods methodology
- Consider the findings of the study relevant to the specific context and to the research field of engineering education

1.7 Methodology

The research problem is addressed in this instance with research into a specific context to understand the perceptions of students in one particular teaching and learning situation and to understand the approaches and practices students' exhibit within it. The research has focused on one academic year of study (involving two cohorts of students) to allow an in-depth understanding to be achieved.

The specific mixed method research methodology used was that of a sequential exploratory study. The sequential nature composed of two phases; a qualitative phase

consisting of semi-structured interviews, and a quantitative phase where a questionnaire was employed. The results are then combined to draw conclusions and to address the research question.

This research is influenced by the pragmatic paradigm. Many of the knowledge claims for pragmatism arise out of 'actions, situations, and consequences' where 'instead of methods being important, the problem is most important, and researchers use all approaches to understand the problem' (Creswell, 2003, p.11). It is felt that taking a pragmatic view to this research allows the postpositivist need to 'examine causes that influence outcome' (Creswell, 2003, p.7) to be considered alongside the constructivist / interpretivist goal of research, which is 'to rely as much as possible on the participants' views of the situation being studied' and also allowing the researcher recognize that their 'own background shapes their interpretation' (Creswell, 2003, p.8).

A Mixed Methods approach to data collection and analysis is used to enable data to be gathered on the current context surrounding the student learning experience. Dahllöf (1991, cited in Entwistle, 2008, p.1) recommends that we should ask 'which method, or which combination of methods – is best... for which goals, for which students, and under which conditions'. The core assumption which forms the basis of the mixed methods research approach to enquiry is defined by Creswell and Garrett (2008). Creswell and Garrett (p.322) state that 'when researchers bring together both quantitative and qualitative research, the strengths of both approaches are combined, leading, it can be assumed, to a better understanding of research problems than either approach alone.' This research will involve two phases of data collection making using an exploratory mixed method strategy with data analysis between stages.

Qualitative and quantitative data was collected and analysed. The qualitative data was thematically analysed and used to develop the quantitative instrument. The quantitative data was then statistically analysed to consider the findings with a larger sample. The results are considered alongside each other, in the true spirit of mixed methods research, and are considered with respect to the particular context and also with their wider relevance to practice.

1.8 Outline of the Remainder of the Report

1.8.1 Chapter 2: Literature Review

The literature review discusses the literature relevant to this study, and provides the theoretical framework which has guided the research. The key aspects of the supporting literature are; models of learning, the significance of perception and context in learning, and the approaches to learning research. Current research specifically in

engineering education has also framed for the study. Critical discussion of the literature has been carried out to provide clear direction and ensure a solid grounding of this research.

1.8.2 Chapter 3: The Research: Paradigm, Strategy and Design

This chapter explains the research methodology and its implementation. The choice of research paradigm that has influenced the choice of methodology, and informed the study design, are explained. The influencing paradigm, and the associated worldviews, justifies the study design and the methodological choices made.

1.8.3 Chapter 4: Research Process

The specific details of the mixed methods sequential exploratory design are explained with description given of both data collection and analysis phases of the research. The dominant source of data was the qualitative data (gathered during the first data collection phase) which was supported by a larger sample of data gathered quantitatively.

This chapter describes the main feature of the mixed method design, that is, the combining or integrating of the qualitative and quantitative data. In this study, integration of the two data types was done through development of a quantitative tool; informed by the qualitative data and analysis. This chapter describes the theory to the instrument design and the procedure for ensuring its reliability and validity in the context of this research.

1.8.4 Chapter 5: Results

This chapter provides the main analysis of the data. Both the qualitative data and supporting quantitative data are used to allow the main findings of this study to be explained.

The chapter provides an introduction to the qualitative data. A summary is presented of the key qualitative themes emerging from the data analysis and also supported by the theoretical framework. This chapter also identifies themes emerging from the data which were less commonly found in the supporting literature.

An introduction to the quantitative data is provided. Data is presented first in its descriptive form to facilitate comparison/integration with the qualitative data from the previous research phase. Following descriptive analysis, the chapter explains the assumptions made to allow correlation and variance analysis to be conducted and then presents these findings.

1.8.5 Chapter 6: Discussion

Chapter 6 draws together the main findings of the study and reflects on the methodological choices and the supporting theoretical framework. The discussion of the results provides a holistic view of the integrated data to address the research questions. The reflection includes consideration of the mixed methods design and the implications for future research.

1.8.6 Chapter 7: Conclusion

Chapter 7 concludes the thesis. It summarises the initial aims of the research and evaluates how well these have been met. It details the contribution of knowledge that is offered to the field of engineering education research.

1.9 Justification and Distinctiveness of the Research

Existing research has identified the range of approaches to studying that student's exhibit and has acknowledged that these are related to the quality of learning achieved. Research has also shown students' perceptions of their teaching and learning context can influence the ways in which they approach their studies. The existing literature has considered a range of subjects (including engineering) although there is little research which concentrates solely on mechanical engineering as a discipline. In addition, there is little evidence of research focussing on Mechanical Engineering second year students and as acknowledged by Lim et al. (2010) 'Year 2 is often a problem year, with students having more difficulties in coping with the modules.'

Whilst a wide range of research has considered contextual factors that affect learning in general terms, there is less evidence of research of this nature specifically within the fundamental mechanical engineering subjects. This research aims to move the current understanding within this discipline forward to determine which contextual factors are perceived by students as having the most influence on their learning experience. What this research offers in terms of an original contribution is an analysis of the role that contexts of learning play in the perception and practices of students in undergraduate mechanical engineering.

There are few reports of students' actual experience of learning on a day-to-day basis (Cronje and Coll, 2008). This research adds to the knowledge of students' perceptions and learning practices during a 'normal' programme of study, considering their current situation. The data is strengthened by the fact that this research design allows student involvement throughout one entire academic year to be studied. This research engages

students at different times throughout the year, to identify any changes in perceptions and practices.

Entwistle (2008) states that it is relatively rare to find well designed and conceptually sound studies that look in depth at subject matter being taught. This is because it is difficult for educational researchers to investigate teaching and learning within specific subject areas when they do not understand the subject-matter being discussed. The research, in this case, is distinctive in that the design and implementation will be carried out by a researcher with both a background in Mechanical Engineering and in engineering education giving the unique perspective of being knowledgeable in both areas. This perspective will be of use in determining any factors which may be considered to be specific to the 'inner logic of the subject' (Entwistle, 2009).

One difficulty faced in engineering education research is the 'wide diversity of subject areas within the discipline (Baillie et al., 2001). Currently, the use of the term 'engineering education' makes no clear distinction as to whether the range of subjects within the discipline are considered, or whether the focus is on one individual subject. The issue of discipline specialities in engineering education research has not been fully resolved in this thesis (nor is it the scope of the thesis to do so). A great deal of research considers discipline divisions however there are arguments which suggest the traditional divisions not be used, stating the problems which need to be solved are common across discipline boundaries (Smith, 1991). The research reported in this thesis focuses on one specific discipline in which the research is lacking, in which the researcher has specific discipline knowledge and in which there was access to the research field. It is further assumed that several of the teaching and learning issues that currently need to be explored within engineering education will have commonalities across subject boundaries.

1.10 Published Work

Appendices A through to appendices C present the items of published work produced by the researcher which are directly related to this research project. Appendix D lists bibliographic information for additional pedagogic research and activity which has been prepared by the author during the timescale of the research project. These items are included within the appendix to demonstrate the academic contribution that the researcher has made to engineering education.

1.11 Conclusion: Introduction Chapter

This chapter has provided an introduction to the research. It has outlined the research questions, aims and objectives.

An overview of the methodology is given, and the nature of each chapter within this thesis described, so that the reader is clear from the outset how the research question has been addressed, how the research builds on strong theoretical grounding, and allows a contribution to knowledge within engineering education to be made.

2. Literature Review

The purpose of this literature review is to give an overview of the body of literature informing this research and to establish a framework in which this research project is positioned. The literature review is also used here to establish and clearly communicate the need for the research project.

Terminology, paradigms, theories and methods associated with learning, and investigating learning, are discussed. Quality of learning and the quality of the learning experience is explored in terms of how it can be measured and how students' approaches to learning can indicate quality of learning. Good practice in education is briefly considered with further focus on the contextual factors affecting learning and students' perceptions of learning. To support the development of this research project engineering education research is considered alongside more general research in teaching and learning.

Whilst the study is focused in the UK, the literature considered does not focus solely on the UK so that an attempt can be made to best understand all relevant existing teaching and learning, and engineering education research.

The figure below is used to largely explain the literature that will be discussed in the following chapter.

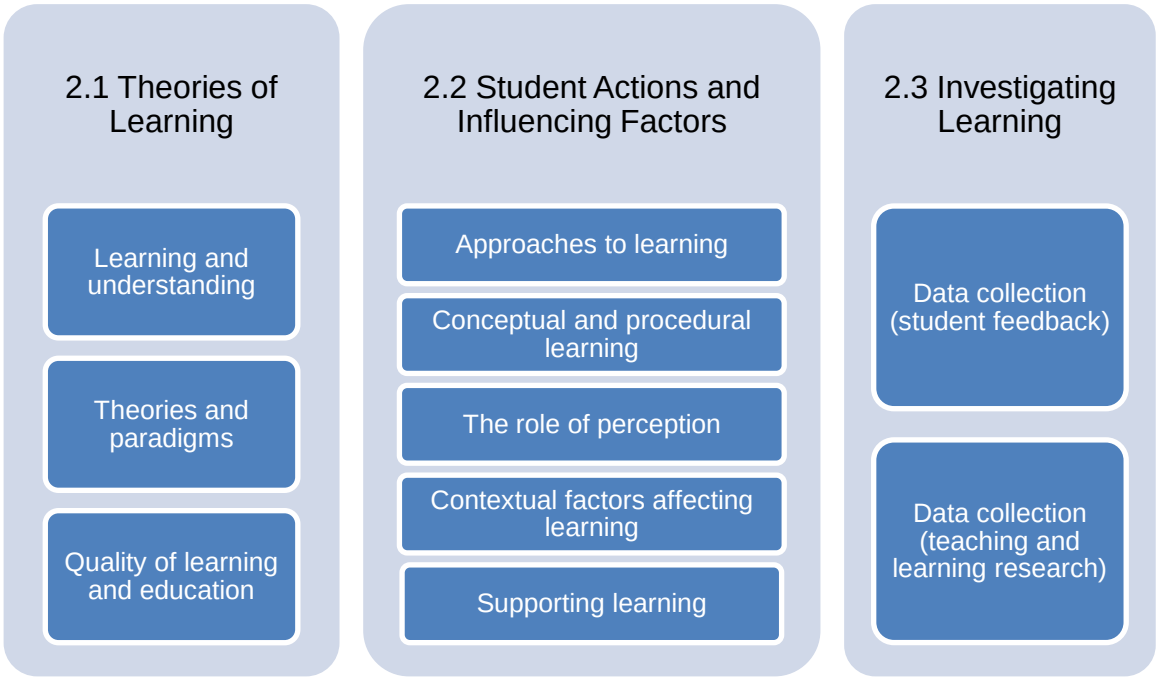

Figure 1: Chapter 2 layout.

2.1 Theories of Learning

2.1.1 Learning and Understanding

Within learning and teaching literature the notion of what it means to learn is often discussed. This section sets out the definitions and interpretation of these terms, as applicable to this discipline of research.

There is an agreement in literature which suggests that to learn is to create a change in the way something is experienced. Booth (2004, p.9) characterised learning following phenomenological studies as 'changing one's way of experiencing some phenomenon' and subsequently characterises teaching as 'creating situations when such change is fostered'. Ramsden's (1987) view of learning is described as a relational view of learning where learning is considered as coming to 'understand' things in distinctively new ways, in which 'understand' can be replaced by 'see', 'conceptualize', or by 'experience'. The views of learning given here agree that learning at the most fundamental level is about causing, influencing and initialising some change in learners. This premise of learning is also shown by Faulconbridge and Dowling (2009).

Nielsen et al. (2008) discuss learning from the constructivist perspective of knowledge creation. They discuss the knowledge society in which learning is not just knowledge acquisition but also a process of creating new knowledge collaboratively when dealing with complex problems involving cross-discipline knowledge and innovative thinking. This view of learning as knowledge creation is pertinent to the current practice of engineering, where teams of engineers are likely to work on a range of multi-disciplinary problems in the workplace. This then suggests that a challenge for engineering education is to prepare engineering students to learn in a workplace which will present increasing complexity throughout their professional life, and equip them with the skills of collaboration, management and innovation as well as awareness of knowledge creation.

When considering the nature of understanding in engineering it is useful to refer to the work of Perkins and his colleagues on Project Zero at Harvard University who developed a *Teaching for Understanding* framework based on a distinctive view of the nature of understanding (Blythe and Perkins, 1998).

> *'Understanding is a matter of being able to do a variety of thought-demanding things with a topic - like explaining, finding evidence and examples, generalising, analogising, and representing the topic in a new way:… being able to take knowledge and use it in new ways' (Perkins & Blythe, p.13).*

Perkins & Blythe's definition is aligned with an engineering specific perspective given by the Engineering Professors Council (1993), who define understanding as 'the capacity to

use concepts creatively in problem solving, in design, in explanations, in fault diagnosis and correction, in asking searching questions etc.'. The Engineering Professors Council also offer a useful term, *'know-how'* which is used to consider 'problem-solving capability' based on 'experience rather than conceptual learning'.

Ramsden (1985) reviewed examples of investigations into how higher education students learn. He identified five main areas for future development of this research: the theory of study process; the conditions for deep approaches to learning; transition, progress, and persistence; studies of everyday learning; and action research into the content and context of learning. The research in this thesis can be considered to be a study of everyday learning.

This thesis is concerned with gaining an insight into how students go about the practice of their learning so that recommendations can be made to support and improve learning. Ramsden (1987, cited in Case, 2000) suggests that 'we ought to study learning because we want to describe what students do; we should apply what we find out to making learning better'.

The definitions of learning and understanding described above are used as a basis for this thesis; helping provide an appreciation of the learning and understanding skills that engineers require, and also highlighting the most basic need for research of this nature.

2.1.2 Influential Theories and Paradigms

As the instruction paradigm suggests 'engineering education in many colleges and institutes, more or less, still follows the traditional instruction and knowledge delivery approach…' (Barr and Tagg, 1995, cited in Agrawal and Khan, 2008). An alternative approach to the 'instruction paradigm' is the 'learning paradigm' or 'constructive paradigm' which infers that 'each learner must construct his/her own knowledge' (Agrawal and Khan, 2008, p.86). Therefore, instruction must create an active role rather than passive one for the learner, where learning is at the centre.

'The constructivist movement claims that lectures often fail to ensure that students learn in a deep manner that is active, transitive and constructive in nature' (Struyven et al., 2006, p.279). Many education studies have shown that students retain only a small fraction of what they hear or read, however, the retention rate increases dramatically when a student says or does – 'when there is hands on learning' (Cole, 1999). Teaching methods which encourage students to be active are intended to 'challenge students to acts of knowledge construction rather than knowledge acquisition' and therefore allow student learning beyond the levels of reproduction and rote learning (Struyven et al., 2006). Recent efforts have seen active learning techniques, which

often enable learning to be related to real-life contexts, (encompassing methods like problem-based and project-organised learning environments) being used in some engineering teaching (Agrawal and Khan, 2008).

'Constructivist theories and practices go together with a shift from a 'test' culture to an 'assessment' culture (Birenbaum, 1996, cited in Struyven et al., 2006). Students are encouraged to be involved as active and informed participants in learning and there is a focus on assessment tasks which are authentic, meaningful, engaging and which mirror realistic contexts. These assessments focus on both the process and products of learning and move away from single test-scores towards a descriptive assessment based on a range of abilities and outcomes (Sambell et al., 1997).

A 'complementary theory to constructivism' (Bruce and McMahon, 2002) is constitutionalism, which is seen by Trigwell and Prosser (1997) to be consistent with a relational view of learning. Ramsden (1987) proposes a relational perspective of teaching and learning in higher education which is holistic and 'links the improvement of the professional practice of teaching with research into student learning.' Ramsden argues that the relational perspective avoids the distance from everyday practice. The relational perspective involves 'inquiry into and reflection on how students learn specific subject matter in particular contexts' where findings can be used modify teaching and assessment. A constitutionalist (and relational) perspective does not conceive of experiences as being made up of a number of separate independent parts causally relating or continuously interacting, but as an indivisible whole where all parts are simultaneously present. Experience however, from this perspective, can be separated into various components for analytic purposes, with parts used to help us develop an understanding of the experience (Prosser and Trigwell, 1999). In this perspective on learning there is considered to be an internal relationship between the individual and the world. In this view the individual and the world cannot be considered independently of one another and are related through the individual's view and awareness of the world. In supporting a relational view of learning Case and Marshall (2004) present data from two engineering studies which clearly indicated that students' use of approach to learning depends very strongly on their perceptions of the course.

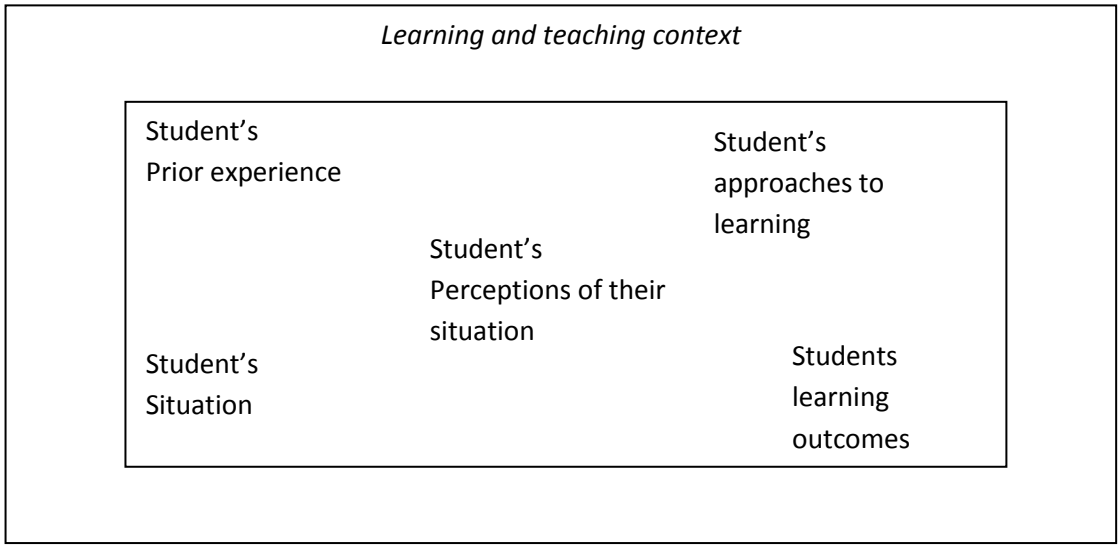

Figure 2: A constitutionalist model of student learning (Prosser and Trigwell, 1999).

Within the teaching and learning literature Biggs research on constructive alignment is widely reported. Constructive alignment calls on staff to think critically about the alignment in their courses between the aims, teaching, learning materials, provision of peer support and the assessment procedures used. Although the principles of aligning aims closely to teaching and assessment is widely recognised throughout course designs and quality assurance procedures, the actual teaching provision for students is considered to potentially create mismatches not anticipated by the staff. The term constructive alignment is designed to 'suggest the importance of aims that focus explicitly on high quality learning and a deep level of understanding' (Entwistle et al., 2002).

The Biggs 3P model of learning (Biggs, 1987, 1999, 2003) demonstrates that learning has three elements which all affect each other; the presage, the process, and the product. There are several versions of this model which differ as research uncovers more detail regarding the relationships between aspects of student learning. According to Lizzio et al. (2002) research efforts addressing the impact of students' perceptions can be readily framed within Biggs's 3P model of learning. In basic terms all parts of the model are related, suggesting that personal and situational factors influence a student to adopt a particular approach to learning. This in turn influences the types of outcomes achieved. The model also suggests that presage factors can also directly influence learning outcomes. If the model is viewed from a constitutionalist perspective on learning, it provides an 'analysis of individuals' awareness of teaching and learning acts in which they are engaged' (Trigwell and Prosser, 1997, p.242). Lizzio et al. (2002) explain that presage factors are those which exist prior to the time of learning, and comprise two broad types: personal characteristics brought to a learning situation by the

student (e.g. prior knowledge, academic ability, personality) and situational characteristics which define the environment (e.g. teaching methods, workload, course structure). Process factors describe how students approach their actual learning and product factors describe the 'learning outcomes (cognitive, affective or behavioural)' which students develop from their experience of the learning process. Makwati et al. (2003) propose that quality is dependent on these three distinct components.

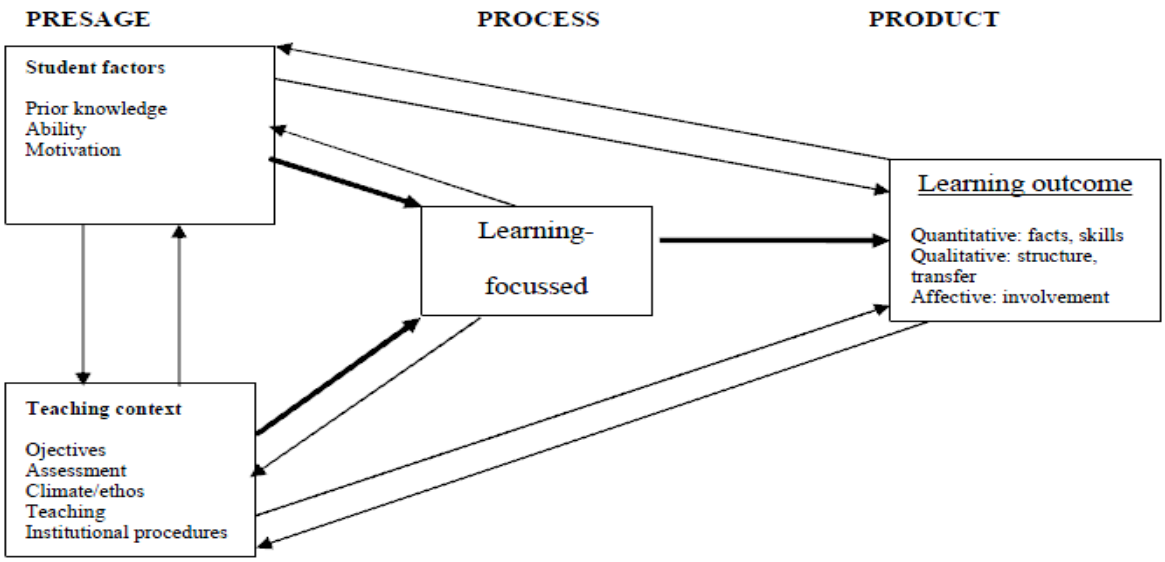

Figure 3: Systems model of study processes (Biggs, 1999).

A slightly earlier version of the 3P Model of Learning in Trigwell and Prosser (1997), which is based on a range of literature on student learning, more clearly emphasised the significance, or presence, of 'students' perceptions of context' in the learning process.

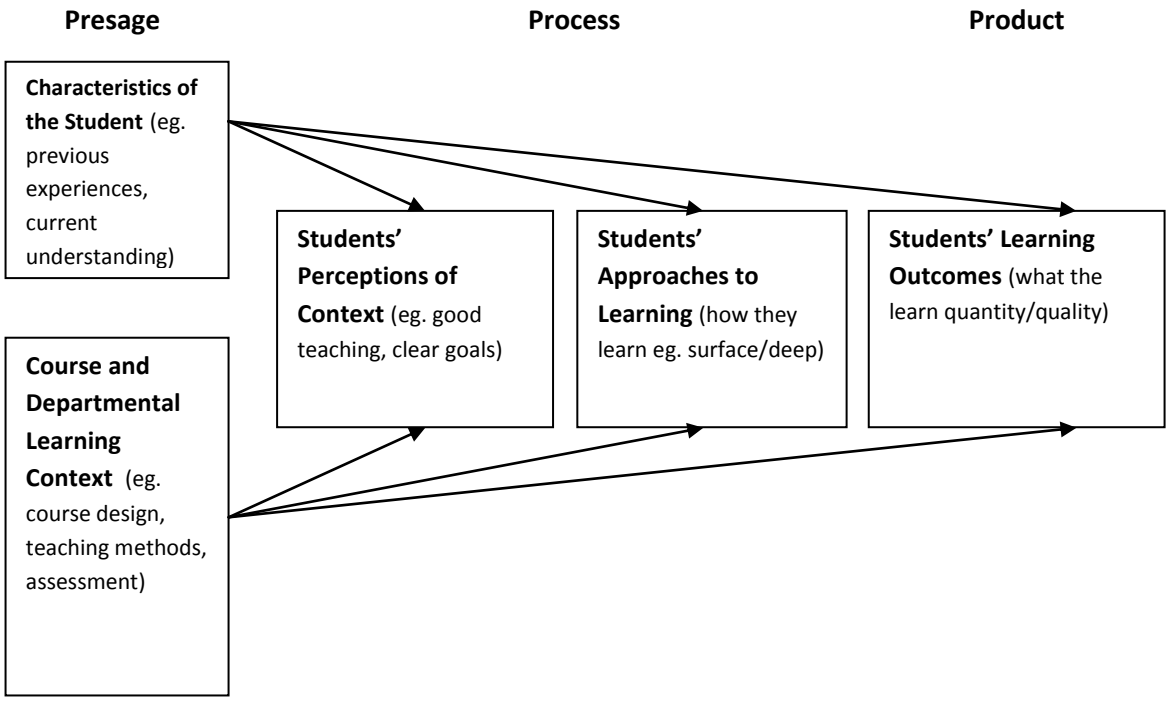

Figure 4: 3P model of student learning. Adapted from Trigwell and Prosser (1997).

The 'three dimensions of learning' model as defined by Illeris (2009) suggests a similar model, although in this case learning is said to be made up of dimensions. The first is said to be 'content' which refers to what is learned; such as knowledge, skills, attitudes and methods. The second dimension, entitled the 'incentive' dimension, considers feelings and motivation required for the learning process and the third component is 'interaction' which considers perception, experience, activity, participation etc.

2.1.3 Quality of Education, Quality of Learning and Knowledge Development

Quality of education is often discussed with respect to quality of learning; where a high level of learning is considered to be an indication of quality. Quality of education encompasses how the teaching and learning is organised and managed, the content of the learning, what level of learning is achieved, what it leads to in term of outcomes, and what goes on in the learning environment (EFA, 2002). It is widely acknowledged that if we want to improve education we need to take into account the views and experiences of the students. Informally, this is part of good teaching and takes place through interaction and dialogue between staff and students. More formally, quality enhancement is defined by Biggs (2003) as being 'about the continuing improvement of teaching in the institution' (p.269). Within higher education, collecting feedback from students on their experiences of teaching and learning has become 'one of the central pillars of the quality process' (Williams and Cappuccini-Ansfield, 2007, p.159).

Wankat et al. (2002) identify one of the difficulties in educational research, and specifically within engineering education research, to be a lack of clarity in what it means to improve learning. A difficulty with the definitions given with respect to learning is that they are 'highly subjective' and cannot be directly observed or calculated. Students' progression in terms of learning can however be inferred from their actions, opinions or observations, which is why understanding the context of learning can be helpful.

Levels of learning have been conceptualised by Bloom's Taxonomy. Lower order thinking skills such as knowledge, comprehension and application relate more to a surface approach towards learning. The higher order thinking skills associated with analysis, synthesis and evaluation relate more to a deep approach to learning. For several years educators have considered the Bloom Taxonomy of Learning to be a valid benchmark that measures a student's level of understanding in a particular subject (Howard et al., 1996). Considering student actions with respect to these levels of learning can help us to infer whether learning is at high or low level, and therefore whether it can be considered to be of high quality.

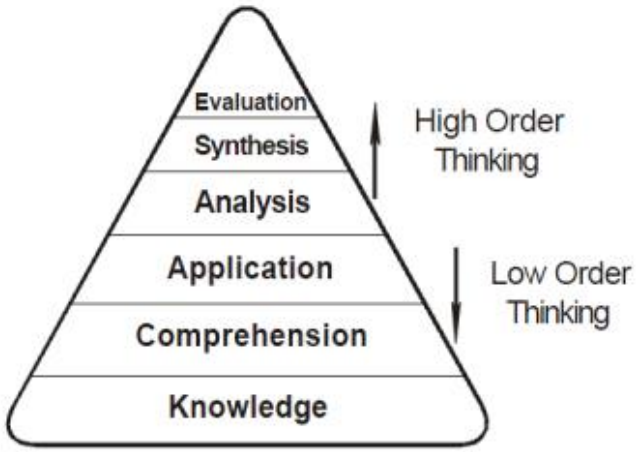

Figure 5: Components of Bloom's Taxonomy of metacognition (Osborn and Nag, 2002).

Biggs (2003, p.1) suggests that we could regard good teaching as 'encouraging students to use the higher-order learning processes that 'academic' students use spontaneously'. The author of this thesis would like to suggest that there are occasions in which engineering students need to have experience of some of the lower level skills before being able to necessarily progress to the higher levels. In these cases the specific context of the learning activity therefore becomes more important; to understand why learning of a particular level is required.

A useful concept relating to knowledge is that it can be either procedural or conceptual, and in engineering it can be accepted that there are times when both are needed. Taraban et al. (2007) explain that 'conceptual and procedural knowledge are two mutually-supportive factors associated with the development of engineering skill.' Rittle-Johnson (2006, p.2) define conceptual knowledge as 'understanding of principles governing a domain and the interrelations between units of knowledge in a domain,' whilst procedural knowledge is defined as the 'ability to execute action sequences to solve problems' (Matthews and Rittle-Johnson, 2009). Alexander and Murphy (1999) discuss the development of conceptual understanding as one of the key processes as a learner grows in competence within a domain. Bransford et al. (1999) explain that experts organise their knowledge around key concepts and suggest organising curricula in a way which helps students acquire conceptual knowledge can also help them to acquire more expert-like knowledge structures. Hegarty-Hazel and Prosser (1991) suggest that there should be more focus on the student learning characteristics related to the development of better conceptual knowledge in engineering education. They indicate that quantities such as force or heat, as well as relationships such as Newton's laws and the laws of thermodynamics, are part of conceptual knowledge in the engineering domain. Rittle-Johnson (2006) suggests that through improving conceptual knowledge students' procedural knowledge and performance can be enhanced.

Entwistle et al. (2002) developed a conceptual framework relating to the quality of learning at university. The framework (Figure 6) suggests that there are six features which enable quality of learning to be achieved; three of which relate to the students', two related to the teaching staff and one to the institution of study. Quality of learning as defined by the Enhancing Teaching-Learning (ETL) project is dependent on students' approaches to learning and studying, their perceptions of the teaching-learning environment and their prior experience knowledge, conceptions and reason for studying. The project team suggest that staff should consider the effect on students' quality of learning that their selection of course material has, and also how material is organised, presented and assessed. Consideration should also be made to the type of teaching-learning environment provided for students to ensure it supports quality learning.

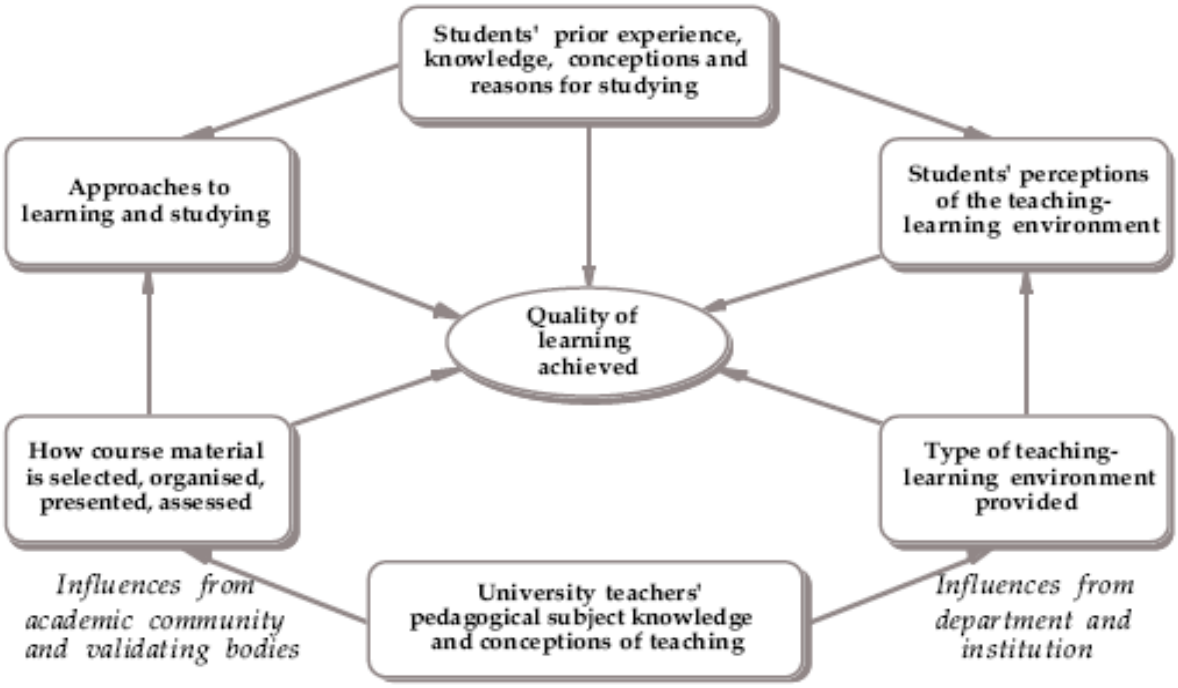

Figure 6: Concepts related to quality of learning at university (Entwistle et al., 2002, p.6).

2.1.4 Summary of Theories of Learning

The literature presented above provides a foundation for this thesis; placing significance in a situation where learning is at the centre of education, with active approaches, student engagement, and an assessment culture rather than a test culture, to support student learning.

The original work of this thesis is positioned within the relational and constitutionalist perspectives as proposed by Ramsden (1987) and Prosser and Trigwell (1997) respectively; all aspects of the learning experience are considered to be interacting and are related to the individual learner. The relational perspective is fundamental in this research; it provides the foundation for the rationale to consider the context of students' learning. Biggs 3P model of learning is used to give clarity to the process of learning and to provide a useful framework in which to consider the range of factors influencing the students in this study.

Whilst the instruction paradigm may still be present, the notion of constructivism and active learning are widely accepted as supporting learning therefore it is considered beneficial in this study to explore how actively involved students are in their own learning.

2.2 Student Actions and Influencing Factors

2.2.1 Approaches to Learning

The terms *deep learning* and *surface learning* were originally used to describe the qualitatively different levels of processes or approaches that students took to any learning situation (Marton and Saljo, 1984). In addition to the deep and surface approaches, additional approaches known as strategic (Entwistle and Ramsden, 1983) or achieving (Biggs, 1987) have also been quoted.

'Approaches to learning are relational' (Trigwell and Prosser, 1997, p.243) and positive correlations between the quality of outcomes of students' learning, and the approach they take, have been identified (Svensson, 2005). Marton et al. (2005) cite the work of Laurillard (1978) and Ramsden (1981), where they explain the difference between the actions of a deep and a surface learner; a deep learner is said to 'engage' and their learning is said to be linked with conceptions of abstracting meaning and understanding reality. Prosser and Trigwell (2001) explain that students who adopt a surface approach to learning are unlikely to achieve the quality of understanding of their subject that would be expected of a university student.

The term *approach* can be considered as a way of characterising what students say they do (Ellis et al., 2008). This definition can be used to help clarify the information students give about their study approaches through interviews and questionnaires during the data collection stage of a research project. It should be acknowledged that students' approaches to learning are not fixed characteristics of students; they can change with tasks (Ramsden, 1992) and are invariably more complex than simply either surface or deep (Prosser and Trigwell, 2001).

A deep approach is found to be associated with; perceptions of high-quality teaching, some independence in choosing what is to be learned, and a clear awareness of the goals and standards required in the subject (Trigwell and Prosser, 1991, p.4). A surface approach has been explained by Entwistle and Ramsden (1983) as one which sees students intending to complete tasks with very little personal engagement. Entwistle et al. (2001) claims that this approach is linked with strategies that are used to carry out routine, unreflective memorisation and procedural problem solving. Restricted conceptual understanding is an inevitable outcome of a student making use of this approach. The deep approach is recognised as not always being the 'best' way to learn however, it is suggested as the only way to fully understand learning material. Students adopting a strategic approach to learning use organised study methods and effective time management, with the aim of achieving high grades (Entwistle and Ramsden,

1983). This approach is linked to the determination to do well, with studying being related to assessment requirements.

A number of studies considering approaches to learning, focus not only on differences in the ways in which students go about their academic work, but also on how differing types of teaching and assessment affect those approaches. Approaches to learning are reported to be impacted by students' prior knowledge, the teaching context, the content and demands of the learning, the institutional context or the motivation of the student (Fowler, 2003, Rowe, 2002).

Research has identified several sub categories of approaches to learning. These include an approach which combines memorising and understanding; *memorising to understand* (Kember, 1996) and another two which focus on procedure and problem-solving; the *procedural deep* approach and the *procedural surface* approach (Case and Marshall, 2004). Case (2000) identified a further three approaches, namely: *Information-based* approach, *Algorithmic* approach and the *Conceptual* approach. As this thesis is only considering how students approach their studies as part of the way in which the research questions will be answered, it was decided not to take the investigation of approach down to these sub-levels; rather this research will focus on surface, deep or strategic approaches as a way of understanding what students do and their learning intentions.

It is suggested by Jones et al. (1997, p.91) that for staff 'one of the most important criteria for determining the effectiveness of a particular teaching style is how the students respond and learn in the environment' created. Useful indications of effectiveness and quality of teaching can therefore be achieved through consideration of what students say they do in a particular context; both in terms of their approach towards their studies (engaging in surface or deep learning approaches) and also in their wider behaviours (motivation, interest, attendance etc.) at particular stages during a course.

2.2.2 Influences on Approach to Learning

Rhem (2009, as cited in Struyven et al., 2006) states that approaches to learning are a phenomenon influenced by the demands of particular learning environments. They can therefore be defined by; features of the learning/teaching context, student characteristics, and experiences of the learner (Evans and Kozhevnikova, 2011).

In terms of disciplinary contexts, (Ramsden, 1992) explains that deep and surface approaches would have very different manifestations in different disciplines. This agrees with the context-dependent nature of approaches as originally proposed by

Marton and Saljo (1984). Ramsden suggests that in science, approaches to teaching might, in some cases, demand a narrow focus on details. This narrow focus on detail on its own could initially appear to be a surface approach, if not considered as part of a chain of complex associations. Entwistle (1997) also argues that researchers need to reformulate approaches to learning within different disciplinary contexts. Entwistle (1997, p.216) claimed that 'the specific processes involved in seeking deep understanding, as well as the balance between them, must vary across subject areas' and identified this as an undeveloped area of research which needs attention. In support of this, Eley (1992, cited in Hall et al., 2004, p.5) found out that students' approaches to learning differed across different subjects within the same course e.g. lower deep and higher surface approaches in accounting compared to business law.

Lizzio et al. (2002) summarised the relationship between student perceptions and approaches to learning, finding that two of the aspects of the university learning environment (appropriate workload and assessment) were significant negative predictors of a surface approach to learning. They found that 'the strongest predictors of students using a deep approach to studying are their perceptions of the quality of the teaching and the appropriateness of the assessment' (ibid, p.39).

It was found in the same study that perceptions of teaching environments and changes in teaching environments may have an impact on students' learning outcomes without necessarily affecting their learning approaches. They found that how the students perceive their current learning environment is actually a stronger contributor to types of learning outcomes at university.

Assessment itself gives students suggestions about what they should be learning during educational processes (Biggs, 1991) and how they should be shaping themselves; this is what Boud (2000) refers to as 'double duty'. Students, for example, will not necessarily tackle assessment tasks in the ways staff may expect because they may have a different perception of the meaning of the task (Laurillard, 2002). The problems with summative assessment have been highlighted; when there is emphasis on exams students play a game. A focus on exams does not contribute to the motivation of students and instead promotes surface learning (Irons, 2008). Newstead (2002, p.3) proposes that the types of assessment used currently 'do not promote conceptual understanding'. The assessment system leads to students simply wanting to get a good mark, rather than being interested in learning for its own sake. Current assessment methods do little to encourage students to 'adopt anything other than a strategic or mechanical approach to their studies' (Newstead, 2002, p.3). It has been established that multiple-choice questions and short-answer tests tend to induce surface approaches (Scouller, 1998). It has also been suggested that some more open forms of

assessment (certain types of essay, authentic problems and project reports) and an *assessment for learning* approach (McDowell et al., 2011) to assessment in general can encourage deep approaches, although systematic investigation of these effects is still lacking.

When designing course content, Entwistle and Ramsden (1983) recommend that deeper approaches to learning can be encouraged by managing student workload, and avoiding excessive course content. Critically however, it is students' perceptions of the teaching and assessment procedures, rather than the actual methods themselves, that most directly affect student learning.

2.2.3 Conceptual and Procedural Learning

Research has shown that there tend to be specific curriculum areas which pose problems to students; particular attention will be given to this during this study to determine what those problem areas are within this particular context.

Z-K Liu (2003) presents the long held view that both thermodynamics and kinetics are 'two of the most difficult subjects to both teach and learn…', explaining that thermodynamics is generally considered to be 'abstract,' making it difficult for students to relate their learning to their own experiences. Mechanics is considered to be a key foundation topic for many engineering disciplines (Goldfinch et al., 2008) and has been found to remain a difficult area for a significant number of students, even in later years of their degree (Dwight and Carew, 2006). In terms of conceptual understanding in Mechanics, Bernhard (2000) explains that students have found it to be one of the most difficult challenges they face.

Research in engineering by Lim et al. (2010) reports that 'Year 2 is often a problem year, with students having more difficulties in coping with the modules'. Mechanical Engineering students found Structural Vibration 1 and Solid Mechanics 2 difficult. A common characteristic of these modules is that they require in-depth understanding of concepts, followed by heavy mathematical or computational manipulations in the applications of these concepts. The students identified that further explanations in theories and concepts could help them. All of the engineering students were markedly 'more concerned about the applications of their studies' than other students; showing that they were considering learning in a career-oriented manner.

Learning conceptual knowledge in engineering science is considered to be an essential element in the development of competence and expertise in engineering (Streveler et al., 2008). Sozbilir (2004) put forward Thomas' 1997 suggestion that many students have trouble understanding more advanced concepts due to the fact that they do not

fully understand the fundamental concepts. Meyer and Land (2003) explain the theory of threshold concepts; these are key concepts that must be understood for deep learning to take place. They are considered to be a portal which opens up a new way of thinking of something that was previously inaccessible. Without an understanding of these threshold concepts the learner is said to be in a state of *liminality*.

Educators within engineering have in recent times begun to systematically investigate students' conceptual understanding (Strevler et al., 2004). Evidence from the literature in cognitive psychology suggests that science and engineering students do not conceptually understand many fundamental molecular-level phenomena (Reiner et al., 2000). Christiansen and Rump (2008) discuss the teaching of thermodynamics in physics, chemical engineering and mechanical engineering, stating that teachers often experience that groups of students have not learned and/or cannot apply the fundamental concepts they should be able to after passing previous exams.

Reiner et al. (2000) explain the basic conceptual quantities which are important in engineering are force, heat, electric current, and light. They quote these as being the source of 'robust misconceptions' among students. The teaching and learning methods used in engineering mechanics have traditionally been very theoretical. The literature illustrates the appropriateness of teaching methods that react to the need for increased conceptual understanding; including the use of project and/or problem based learning, and the use of appropriate software (Covill et al., 2007). 'Interaction between enhanced conceptual knowledge and related procedural knowledge is a fertile area for investigation' (Streveler et al., 2008, p.290). No causal evidence was found to link increased conceptual understanding with increased procedural knowledge (Rittle-Johnson and Seiger, 1998, cited in Streveler et al., 2008). This supports the earlier assumption that there may be a need for students to acquire, and make use of both conceptual understanding and procedural learning within engineering education.

2.2.4 The Role of Perception in Learning

> 'The recognition that students' personal learning experiences may provide valuable data for understanding the nature of student learning is undoubtedly one of the most important discoveries of the past 40 years of research on learning in higher education' (Scheja, 2006, p.422).

Already discussed in this chapter is the' 3P model of learning which demonstrates how 'presage factors' such as perceptions of the learning environment can also directly influence learning outcomes. To really understand how students view and experience teaching and learning it is proposed that evaluations should focus on what students' perceive to be 'key aspects of teaching' (Williams and Brennan, 2003, p.33).

University students can be assumed to bring experiences of previous education as well as previous knowledge and understanding to any course; all of which influence how they go about studying and how they make sense of the subject matter. Students often enter university with firmly established study habits which may not be appropriate for higher education (Entwistle et al., 2002). There are wide differences in students' prior knowledge and experience that lead to markedly different approaches to studying and also to contrasting perceptions of the teaching-learning environments they experience (Entwistle and Ramsden, 1983).

Booth (2004, p.17) presents the view that 'every task or situation has a perceived relevance' and Hein and Hamlin (2005) found that typically, 'students learn more and do better in courses where they perceive the knowledge gained will benefit them. Ellis et al. (2008) explain that students' beliefs about aspects such as what it is possible to learn, the demands of a course's assessment regime or the standards a teacher expects, affect the processes that transform the task into the activity that results in learning. Ellis et al. (2008) cite the work of Goodyear et al. (2005) and Struyven et al. (2006) who also concluded that how students interpret and experience a course is more important than the course's underlying pedagogical intentions. If students sense that a course is badly implemented, that they are overloaded with work, that there are no clear goals, and poor feedback is given, then they are more likely to respond with surface than deep approaches, irrespective of the pedagogy or the technology being deployed by the teacher. Research studies suggest that if more emphasis is placed on the delivery system and the pedagogy, in addition to the institutional and interpersonal contexts of learning, then 'curricular planning efforts will reap much greater payoffs in terms of student outcomes' (Smith et al., 2005, p.1).

Entwistle (2008, p.13) clarifies that 'it is not so much the teaching-learning environment we provide that affects the learning approaches of individual learners, as their perceptions of it'.

Studies of student perceptions of their learning communities are often confined to reports of research interventions, with few reports of their actual, current learning communities (Cronje and Coll, 2008). Cronje and Coll offer an example of an exception; they carried out research in which students' perceptions were considered without the presence of an intervention. Students identified factors which were considered to be important to them such as organisation and planning of lectures, variety of teaching approaches, relation of theory to practice and access to materials on-line.

Both staff and students highlight the importance of coherence, continuity and connectedness in teaching and learning over the course of a degree (Hein and Hamlin,

2005). Knowles (1990, cited in, Faulconbridge and Dowling, 2009, p.2) explain that 'establishing a credible need for an educational activity and being able to communicate this effectively to the students is critical in adult education.' When the need for learning is expressed in relevant and practical terms, learners are more likely to be motivated and more likely to adopt deeper approaches to learning. Objectives and outcomes of a course should be put into a context which is meaningful for students.

Students' perceptions of the appropriateness of the workload within their programme are associated with levels of satisfaction (Lizzio et al., 2002). Students within the Lizzio et al., study also indicate that they develop higher levels of generic and transferable skills in programmes which are 'less packed'. An engineering study on student learning (Scheja, 2002) identified experiences of a particular lag in the process of coming to understand course material, which seemed to be prominent among students who were struggling to keep up with what they perceived to be an excessively rapid teaching pace. It is suggested by Scheja (2006, p.421) that the concept of delayed understanding captures the complications of an engineering study situation in which 'a perceived lack of time to reflect on learning material obstructs students' understanding of course material'. It also indicates generally that 'time to reflect on previous experiences is an essential component of the process of coming to understand learning material' within an educational setting.

Students' perceptions of the instructional methods that teachers use are adaptive responses. We can study the relationship between contexts and learning to see how these responses may help or hinder the achievement of the desired learning outcomes (Ramsden, 1987). Students try to interpret the situation in higher education in terms of their previous experience; in which teachers may have provided external regulation i.e. knowledge and strong guidance about what work to do and when it is required. University education, on the other hand, depends increasingly on self-regulation in learning and studying (Vermunt, 1998). Kestell and Missingham (2007) focused on the student perception of lecturer quality in a school of Mechanical Engineering; and concluded that appropriate humour in lectures was an extremely valuable tool which improved the students' learning experience.

Ferreira and Santoso (2008, p.3) conducted research in accounting education and found that preconceptions of the discipline are likely to affect student attitudes towards learning and consequently influence student performance. Their findings indicate that student performance is negatively affected by the discipline preconceptions, 'but only by those at the beginning of the semester (not those at the end of the semester).' They also suggest that 'positive perceptions at the end of the semester influence student

performance, while positive perceptions at the start of the semester only have an indirect effect on student performance.'

Jungert (2008, p.201) conducted a longitudinal study which examined how students' perceptions of their 'opportunities to influence their study environment' affected their studies. Students from a Master's programme in Engineering were studied and results indicated that the students' perceptions of their study environment caused three types of response: (i) to adapt to the environment and to study alone; (ii) to try to change the programme, to create an individual curriculum and to interact with teachers; and (iii) to cooperate with their peers.

It has also been noted that students in different cultures go about the 'process of learning' in different ways (Cowan and Fordyce, 1987). They may even have different perceptions of staff and view the role of the teacher differently—with some cultures accepting the teacher as a 'figure of authority' rather than an 'agent facilitating student understanding'. The way students evaluate and consider learning experiences may also be related to the different types of student; there are those who are motivated with 'clear academic or career plans' and also there may be others who are there to 'get qualifications for jobs' (Biggs, 2003, p.3).

2.2.5 Contextual Factors Affecting Learning

Within the field of engineering education existing studies have tended to consider teaching and learning in two ways; in a generic module/programme evaluation sense using pre-defined questionnaires, or with respect to evaluation of small-scale teaching innovations. Whilst these types of study have provided fruitful results they have not provided an opportunity for the whole context of the teaching and learning situation to be considered, neither alongside the use of generic questionnaires, or with respect to the full context in which the innovations have been applied. There are examples of in-depth context specific investigations in Electrical Engineering (Entwistle et al., 2005) and Chemical Engineering (Case, 2000) however there is less evidence of published information evaluating students' experiences specifically in Mechanical Engineering.

Research inevitably involves balancing depth and detail with breath and overview (Faulconbridge and Dowling, 2009). Scheja (2006, p.429) identify that within the research there is still room for more detailed analyses of the 'variation of intentions and beliefs that influence individual students' actions in particular course settings'.

Svinicki (2010) describes typical educational research variables as being related to teachers, students and the context. Bisgaard et al. (2004, p.31) give a definition of context as 'the interrelated conditions in which something exists or occurs'. They

explain that this means context is 'the mutual relationship between the many conditions that exist in a given situation.' There is a '…belief that context forms an integral part of the investigation of any phenomenon or relationship' (Trigwell and Prosser, 1991, p.14). A contextual factor may have different types of contextual impacts that differentially mirror the types of contexts that exist in a situation. Seating arrangements, for example, have both social and political impacts, as well as physical effects (Tessmer and Harris, 1992).

As the context of higher education is changing (Fry et al., 2009), it is suggested that when examining relationships between research and teaching, the changing context must also be considered (Brew, 1999). Benson and Samarawickrema (2007, p.61) explain that definition of context may include a range of factors, 'from the specific characteristics of the learning and teaching environment, to disciplinary, institutional and systematic variables, and beyond that to broad social influences and personal issues affecting students' lives.'

Prosser and Trigwell (1999) use *context* to describe what they consider to be any element of the 'learning world' that does not directly include the student. It could be the teaching package prepared by the teacher or it could be the teaching, it could also be the science laboratory or the engineering workplace. Bhattacharya (2004) acknowledges that 'more rigorous and more detailed investigation in particular contexts and cultures is needed to determine the exact characteristics that contribute towards teaching excellence.'

In the frame of this research the term 'context' will apply to any of the factors outlined in this section, or any other factors which are identified as a result of data collection which can be seen to influence the perception or approach of students with respect to their learning. The complex nature of education means that no aspect can be considered in isolation; investigations in engineering education must consider the whole context. Tessmer and Richey (1997, p.87) explain that 'context is not the additive influence of discrete entities but rather the simultaneous interaction of a number of mutually influential factors'. They discuss how contextual elements can be engineered to facilitate learning and performance, and in fact context can be considered as 'an element that surrounds its members as a continuous presence'. It is suggested that attempting to fix, what are assumed to be necessary skills, without 'considering the learning context and the meaning of learning to the students is worse than useless' (Ramsden, 1985, p.5).

Taylor and Hyde (2000) discuss how research has shown a chain of relationships linking concepts of learning, perceptions of teaching and learning, approaches to learning and

quality of learning outcomes. They put forward a perspective that students' perceptions of context (encompassing teaching quality and clarity of goals) are a function of individual student characteristics (such as previous experiences and current understanding) as well as being a function of the course learning context (course design, teaching methods and assessment). Vest (2006) recommends that it is more important for engineering schools to provide students with stimulating and demanding environments than specifying curricular details.

Ellis et al. (2008) discuss that research on student learning in higher education tends to partition the factors that relate to learning outcomes into two sets: student factors and teaching/environmental factors. Tessmer and Harris (1992) recognise a distinction in the learning situation between the immediate learning environment (the classroom or workplace) and its' surrounding support environment (the larger institution or organisation); the context affecting student learning therefore has a number of dimensions.

Cashin and Downey (1995) report that learning climates within disciplines are distinctive with relation to learning goals and instructional methods; physical scientists emphasise facts, principles, and problem solving whereas in the social sciences and humanities a critical perspective and communication skills are important (Stark et al., 1989, cited in, Donald, 1999). As Biggs (2003, p.2) identifies, what works in teaching is 'a complex resolution between us and the system that operates in the particular institution in which we are working.' We have to adjust teaching within the context we are working; including in relation to subject matter, resources, students and our own strengths and weaknesses.

2.2.6 Supporting Learning

The ETL project, which took place from 2001-2005, had the purpose of exploring ways to enhance teaching-learning environments (Entwistle et al., 2005). The project confirmed and strengthened earlier conclusions about the relationships between students' perceptions of teaching-learning environments, their approaches to learning and studying, and their levels of academic performance. The project also showed the importance of treating subject areas as having distinctive teaching methods which reflect the specific nature of a subject.

The findings of the ETL project warn against looking for universal developments in university teaching and learning. They suggest that language, concepts used in analysis, and finally innovations, have to be compatible with teaching in the discipline and the ways of thinking and practising that are most prominent within a particular course or module (Entwistle, 2005). These findings support the design of the research

reported in this thesis; that it is worthwhile to consider a particular subject area in detail to identify the particular ways of thinking and practicing.

The ETL project also produced a concept map which demonstrates elements of the teaching and learning environment which are viewed to support quality learning (Entwistle, 2003). The concept map was produced from the theories and concepts that were identified to describe the 'inner' teaching-learning environment. The concept-map (Figure 7) draws on social-psychological aspects affecting teaching-learning, such as student cultures and staff-student relationships (Entwistle, 2003), and identifies four key areas which are considered to be influential; 'course contexts', 'teaching and assessing content', 'staff-student relationships' and 'students and student cultures'. While mechanical engineering was not considered by the ETL project team they did focus on electronic engineering where they found it 'particularly valuable to use the notions of inner logic and delayed understanding (Entwistle, 2005) to explain the experiences students reported.

Research by Entwistle (2008, p.21) suggests that there is actually an 'inner logic of a subject and its pedagogy'. Entwistle explains that 'approaches to teaching and the methods used to encourage conceptual understanding necessarily reflect the nature of knowledge and ways of thinking within a particular discipline' (2008, p.29). He does however acknowledge that there is a way of thinking about the pedagogy that can be generalised. Entwistle (2006) provided examples of what these might be in electrical engineering and suggested that to support students, learning interest should be created through professional links. Staff should show enthusiasm for the subject and its value, provide worked examples with explanations, think out loud while working out examples and offer thorough explanations. Students should be encouraged to discuss problems, they should complete tutorial problems which increase in difficulty, and have their individual progress regularly checked.

The research in this thesis is therefore based on the assumption that generalised pedagogy can and does exist, however, within teaching and learning, it acknowledges that attention does need to be given to the ways of thinking specifically within the discipline.

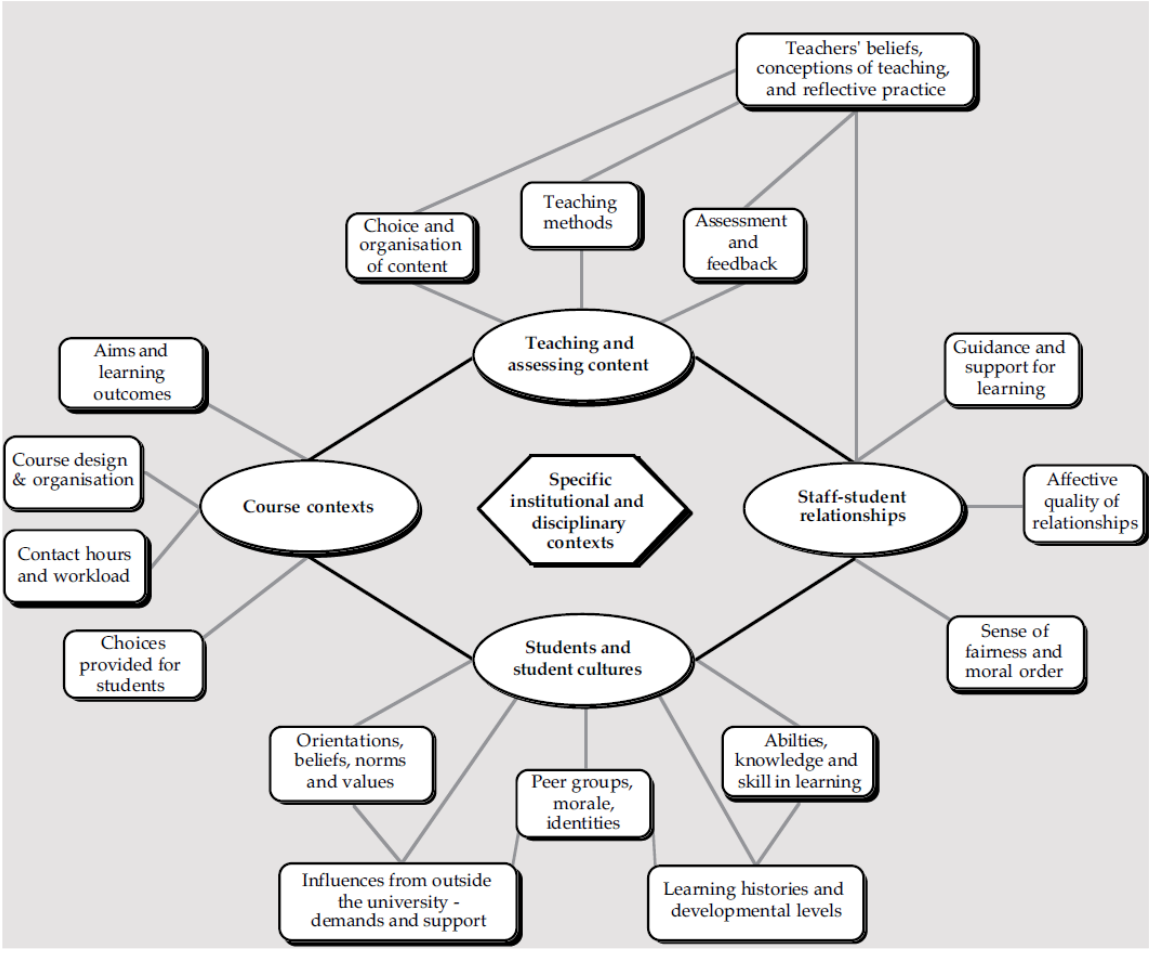

Figure 7: Conceptual map of the 'inner' teaching-learning environment (Entwistle, 2003, p.7).

Giving specific detail to the theme of supporting learning is the research by Agrawal and Khan (2008). They suggest that to obtain a better quality of education along with better outcomes, the main focus should be on the processes, i.e. the teaching and learning activities inside a classroom. The effectiveness of instruction (in terms of the learning outcomes) depends on a number of factors. The first of the factors which should be considered relates to the quality of instructions or lecture, that is, for example, how well the instructor is able to communicate the basic concepts and knowledge of a particular subject to the students. There are other factors which should be considered relating to the students such as their ability to learn (competence, style, role or current activity) and their motivation, interest and intention. The availability of texts, reference books and class notes should also be considered in addition to the classroom ambience. All of these factors should be taken into consideration as far as possible while measuring the learning outcomes or the effectiveness of instructions.

Chickering and Gamson (1987) suggest seven basic principles for good practice in undergraduate education which reflect the complex frameworks developed to understand learning. They suggest that good practice from university perspective;

- Emphasises time-on-task,
- Gives prompt feedback,
- Encourages active learning,
- Communicates high expectations,
- Respects diverse talents and ways of learning,
- Develops reciprocity and co-operation amongst students,
- Encourages contact between students and staff.

To facilitate learning in engineering education the design, development and delivery must be carefully undertaken carefully. The challenges of delivering effective engineering education are further complicated due to the many issues associated with teaching diverse groups of adult learners and the challenges of exploring technically complex engineering topics (Faulconbridge and Dowling, 2009). Felder et al. (2000) suggest techniques that have been shown to be effective in the specific context of engineering education. They are similar to those by Chickering and Gamson (1987) in that they suggest:

- Communication of clear instructional objectives,
- The promotion of active learning and cooperative learning,
- That a sense of concern about students' learning should be conveyed,
- Challenging but fair tests be used,
- That the relevance of course material should be established and taught inductively,
- That there should be a balance of concrete and abstract information in every course.

Baillie and Moore (2004) explain that within engineering education the choice of teaching approach, or the methods used to help students learn, need to match learning and assessment methods. In his work 'Beyond Excellence: Achieving Brilliance in Engineering Education' Cowdroy (2008) claims that the standard method of lecturing then testing students is failing. In the standard lecture students are not engaged in deep learning as they are said to do their learning usually at home, whilst only studying during lectures (Elen and Lowyck, 1998). Students' behaviour also indicates that they don't intend to learn during lectures, they will instead, engage in learning at a later time (Winne and Marx, 1980).

The participants of the study by Pomales-García and Liu (2007) defined excellence in engineering education with a number of keywords which show the diversity of the subject. The key words include: analytical, applied and hands-on, challenging, changing, current, multidimensional, multidisciplinary, preparing for the future and long lasting. To achieve excellence, use of examples and, specifically access to *real-life* examples, was considered to be important.

Pongboriboon (1993) conducted a study to understand which factors most strongly affected the performance of students on first-year mathematics programs in Thailand. Included in the group of students were engineering, agriculture, science, education, medicine and nursing students. The study found several variables which were statistically significant predictors of first-year performance; these included prior achievement, self-esteem, study habits, confidence and attitude towards the subject.

Holman & Piling (2004) reported on an approach to teaching Thermodynamics which made an attempt to conceptualise what was being taught through use of 'contextualised insertions.' When students are unable to make connections to their prior knowledge, 'successful' students will 'memorize significant amounts of content to pass an exam, but they will be unable to apply that knowledge to practical experiences' (Clough and Kauffman, 1999, p.529). Concepts need to be grounded in experience e.g. of commonplace objects like pumps. Course design needs to consider how to connect concepts within the course and to decide how fundamental particular concepts are. 'Deciding what is fundamental and its likelihood of application is often contentious,' (Clough and Kauffman, 1999, p.529) one approach in doing so is to produce a concept map of the big picture, including important concepts and critical connections.

Many studies have shown that the more students work in cooperative learning groups the more they learn: they understand better what they are learning, it is easier for them to remember what they learn, and they feel better about themselves, the class, and their classmates (Johnson et al., 1998). Springer et al. (1999, cited in, Wankat et al, 2002) meta-analysed the research for college-level engineering, science, mathematics and technology and found students' persistence and achievement in these fields was significant and the students had positive attitudes toward their education. Learning can also be encouraged through use of interactive multimedia. Regan and Sheppard (1996) for example made use of the software to enrich the learning experience for example, through providing case studies and tutorials to develop specific skills. Tsai et al. (2004), made use of technology to provide simulation examples for dynamics and fluid mechanics courses.

Studies in the USA investigating the relationship between out-of-class activities and the quality of student learning outcomes have implied that there will be many factors associated with learning that lie outside the control of the individual academic or department (Erwin and Knight, 1995, cited in, Harvey and Knight, 1996). Murray (1991, cited in, Harvey and Knight, 1996) explains, for example, that 'the main factor determining student learning... is individual studying by students outside the classroom.' Based on this view the evaluation of teaching and learning should therefore also consider what work students have been encouraged to do in their own time and how their learning takes place in the context beyond the immediate university environment.

2.2.7 Summary of Student Actions and the Influencing Factors

The particular context in which the teaching and learning takes place plays a significant role in students' learning and the principle that approaches to learning are relational has been well established in higher education literature. The literature has also shown that there are multiple factors affecting learning in engineering. In this thesis the unique nature of the learning and teaching context will be explored from a student perspective to understand which elements of it they find key to their learning.

Previous research has shown that deeper approaches to learning are linked to perceptions of the learning environment, including quality and organisation of the teaching, the workload and the appropriateness of assessment. Characteristics of the student, their preconceptions of the discipline and their prior learning experiences are also likely to affect students' attitudes towards learning. This study will explore whether all, or only some, of these factors are considered to influence the practices of students in this study, and in addition whether these students identify any additional influential factors.

Standard lectures are considered in fail in encouraging deep approaches in engineering. Engineering students in general (and specifically within mechanical engineering) have been shown to consider the use of examples as a factor in describing excellence in engineering education. The value placed on worked examples will therefore be considered within this study.

The ETL project showed the importance of treating subject areas as having distinctive teaching methods which reflect the specific nature of a subject. This literature review has therefore highlighted the need to investigate whether there are any aspects of perception of practice which differ from the literature and could indicate ways of thinking and practicing for this discipline and this specific year of study?

Research has indicated that the specific curriculum areas of mechanics or thermodynamics may pose problems for students in mechanical engineering; this will be explored in this study to see if it is true for these students within their second year of study.

The idea of conceptual and procedural knowledge is one which the author feels is significant within engineering education. It suggests that if students are carrying out conceptual learning they will be working on achieving higher level and deeper learning therefore the 'type' of learning students describe will be explored.

In summary, it is clear from the range of literature that student, teaching and environmental factors cannot be neatly separated; this research therefore aims to investigate students' perceptions and their approaches to learning in response to the all-encompassing context of their learning.

2.3 Investigating Learning

To evaluate success with respect to overall teaching-learning outcomes it is essential to understand students' learning techniques and their difficulties (Lim et al., 2010). To inform the selection of data collection methods a number of existing data collection methods from teaching and learning (practice and research) were explored/reviewed.

2.3.1 Student Feedback Methods

Student ratings of teaching effectiveness have been shown to be reasonably valid, reliable, and useful as feedback to faculty (Marsh, 2007).

Student feedback is often collected through the use of course evaluation surveys, student satisfaction surveys, or nationally in the UK, through the National Student Survey (NSS). All of these tools explore students' perceptions and experiences of their teaching and learning experience in some way. Many universities make use of student feedback questionnaires near the end of each semester with Kember et al. (2002, p.411) suggesting that 'they must be the most widely used form of teaching evaluation in higher education'. The drawback of all of these standard formats is that the level of detail which can be explored is often fixed, and does not respond to specific contexts. There are evaluation methods used more specifically within teaching and learning research such as inventories and interviews which do allow for some element of context to be explored. Kember and Wong (2000) also identified another limitation; when students complete course evaluations they actually rate according to their own conceptions of teaching and may therefore poorly rate teachers who use methods deriving from those conceptions.

Module feedback is most effective in 'obtaining relevant information' for 'implementation of improvements to the teaching and learning process' (Brennan et al., 2003, cited in, Lim et al., 2010). Several of the studies investigating students' experiences discuss the Course Experience Questionnaire (CEQ) as developed by Ramsden (Lizzio et al., 2002, Broomfield and Bligh, 1998). The CEQ is a standard student evaluation instrument which is designed to use students' perceptions to measure teaching within academic course units (Ramsden, 1991).

In contrast to standard instruments such as the CEQ, Biggs (2003) suggests that questionnaires which are used to give feedback regarding teaching and learning actually make much more sense when questions are tailored to courses and situations and where the questions can give feedback which is specific. The Student Satisfaction Approach (SSA) uses a survey which is tailored specifically to the needs of students at particular institutions. It has the aim of measuring satisfaction with the student experience (Williams and Cappuccini-Ansfield, 2007). Race (2001) suggests a similar method for teaching reviews, introducing the possibility of using preliminary interviews with a representative selection of students to establish the agenda for feedback questionnaires. A number of institutions, both in the UK and overseas, have adopted the SSA as the central tool in their quality management processes (Williams and Cappuccini-Ansfield, 2007).

A recent addition to the wealth of questionnaires is the SEM (Student Evaluation of Module questionnaire) (Lim et al., 2010) which has been used specifically in an engineering environment. The target students for this study were second year undergraduates at an overseas campus, studying a range of engineering programmes. The SEM aims to provide students with a platform for feedback on individual modules at their institution. The SEM uses closed likert-type items to allow students to rate module delivery, learning outcomes and facilities. A small number of open-ended questions are also used which ask students to indicate what liked about modules, how modules could be improved, and also add any further comments they may have.

Richardson (2005, p.401) recognises that standard instruments do have advantages; they can provide 'an opportunity to obtain feedback from the entire population of students' and they can 'document the experiences of the student population in a more or less systematic way'. Whilst acknowledging the advantages of questionnaires in that they are quick, anonymous and amenable to statistical analysis, Race (2001) discusses the *Ticky Box Syndrome,* where people who encounter excessive use of questionnaires become likely to make instant responses to questions; with responses made on a surface level rather than as a result of reflection and critical thinking. A report to the

Higher Education Funding Council for England stated that, to improve learning within a module, the use of direct, qualitative feedback is preferable to questionnaires (Harvey, 2001). Qualitative discussion between staff and students about modules provide prompt, and in-depth, understanding of both positive and negative aspects.

2.3.2 Researching Teaching and Learning

Olds et al. (2005) state that successful research in engineering education will involve the application of methodologies derived from other experiences in higher education. They include in this; surveys, interviews, focus groups, conversational analysis, and observation, which can all be used to study phenomena related to teaching and learning in the field of engineering.

Current research methodologies that assess engineering education are divided into two primary types by Olds et al. (2005); studies which are either 'descriptive' and describe the current state of a phenomenon or are 'experimental' and examine how a phenomenon changes as a result of an intervention. Qualitative, quantitative, and mixed research methods are often used for the descriptive designs, whilst quantitative methods are usually used for experimental study designs. Olds et al. agree with Feuer et al. (2002) who argue that the research questions, not methods, should drive educational research and assessments. Borrego et al. (2009, p.5) conducted a research review which had the purpose of opening up 'dialog about quantitative, qualitative, and mixed research methods in engineering education research'. They found that '...no particular method is privileged over any other. Rather, the choice must be driven by research questions' and suggest that 'quantitative, qualitative, and mixed approaches will be essential in the future'.

The most commonly used assessment instruments in studies reported in the Journal of Engineering Education are student surveys and end-of-course rating surveys (Wankat, 1999). Surveys are easy to use and often satisfy reviewers to engineering education publications; however, Wankat et al. (2002) identify that results which are based entirely on surveys can lack the credibility 'needed to persuade engineering professors to modify their teaching methods'.

Wankat et al. (2002) found that published studies which go beyond using surveys have included comparisons of test scores and retention rates for experimental and control groups. This type of quantitative study can be considered to be more credible to engineering faculty than survey-based studies however few engineering classes have enough students to form control groups and yield statistically significant results.

Additional challenges to using quantitative studies in engineering education are the complexities and ethical issues involved in student participant research. In actual fact 'many innovations in engineering education seem to develop more by natural growth and change rather than from preplanning' (Wankat, 2002, p.7).

Qualitative research methods usually associated with the social sciences, for example methods that involve content analysis of student transcripts, are seen in more recent engineering education literature (Wankat et al., 2002). These qualitative methods offer the opportunity to asses some of the broader engineering skills rather than the technical discipline knowledge.

In contrast to student feedback gathered for an operational/institutional purpose, much of the research on approaches to studying at university has been based on phenomenographic interviews with students. Phenomenography provides a way of identifying and mapping key differences in the way something is experienced. It does not provide 'rich, thick, grounded descriptions of individual experiences' or measures of 'how much something is experienced' (Prosser et al., 2007, p.51). It can be considered that phenomenography focuses on conceptualising the variation in *how* a phenomenon is experienced. The pragmatic approach of this research aims to consider how students' as a cohort perceive their teaching and learning, and how they go about the practice of learning. The research in this thesis therefore considers *what* is experienced by the student cohort and *what* practices they employ in their learning. The use of phenomenography in this instance would not provide a practical method for understanding the way in which the wider cohort perceived and practiced within their teaching and learning context.

Recent research in the field has increasingly come to use inventory methodologies to enable large scale investigations of students' study patterns in higher education (Scheja, 2006). These instruments have been developed to explore the concepts generated in qualitative research to produce quantitative scores on scales designed to capture key aspects of studying and learning in higher education (Richardson, 2000). There has been less emphasis on individual students' experiences of understanding since much of this effort has been aimed at describing and classifying study patterns among groups of students (Helmstad, 1999, cited in, Scheja, 2002).

Standard inventory style questionnaires have been developed to indicate students' overall approaches to studying, their perceptions of the teaching-learning environments and related aspects of students' attitudes and experience; these include the Approaches to Study Inventory (ASI) and the Course Perceptions Questionnaire (CPQ) (both in Entwistle and Ramsden, 1983). The use of inventories as data collection methods

allows for information to be gathered from a large number of students but they do rely on students honestly and accurately describing how they study. Entwistle et al., (2002) warn that in aiming for simplicity the conceptual basis of several teaching and learning inventories has 'left out some important aspects of studying, such as; self-regulation, emotion, 'communities of practice' and collaboration in learning.'

The ETL project developed tools, including questionnaires, to allow course organisers to monitor the effects of teaching-learning environments in their departments (Entwistle et al., 2002). Two questionnaires were developed for the project: the first, the *Learning and Studying Questionnaire* (LSQ) was designed to indicate students' general learning orientations and approaches to studying as they embark on target modules; the second, the *Experiences of Teaching and Learning Questionnaire* (ETLQ) focuses on the ways students have actually studied that module and on their perceptions of the teaching-learning environment they experienced (ETL-Project, 2001-2005). A shortened version of the ETLQ was also produced, the SETLQ (ETL-Project, 2005).

The LSQ covered learning orientations, reasons for taking a particular course and also included the *Approaches to Learning and Studying Inventory* (ALSI) (developed from earlier inventories). The final section asks students to rate on a nine-point scale how well they had been doing on the course so far, based where possible, on their actual grades obtained.

The ETLQ was developed to capture, for a specific course module, students' approaches to studying and their perceptions of the teaching-learning environment. Whilst this questionnaire focussed on a specific course unit it is made up of fixed questions which do not allow for any aspects specific to the context of that unit, or the learning experience, to emerge. It includes a short form of the Approaches to Learning and Studying Inventory, a section which covers the students' perceptions of the teaching and learning they had experienced on the course, questions which ask about the demands that students felt the course unit made in terms of knowledge requirements and learning processes, and the fourth section asked what students felt they had actually gained from the unit.

Overall, it is observed that educational outcomes are fundamentally affected by teaching and learning processes although according to Karapetrovic and Rajamani (1998, cited in Agrawal and Khan, 2008), a student's learning is not necessarily directly proportional to instructor's teaching performance. From a quality viewpoint within education most research has been conducted on educational outcomes (e.g. graduation rates, final examination scores/grades etc.) rather than the educational processes which generate such outcomes (Agrawal and Khan, 2008).

Lizzio et al. (2002, p.37) found that the construct of good teaching on the CEQ (a combination of the good teaching, appropriate assessment, clear goals and standards, and independence in learning scales) was 'positively associated with students' reporting a deep approach to their study'. This demonstrated that students who perceive their learning environments to exhibit good teaching, report that they are more likely to adopt 'meaning-based' strategies than reproductive, learning strategies.

Diseth et al. (2006, p.156) looked to compare undergraduate psychology students' scores from the CEQ, with the scores from an abbreviated version of the Approaches and Study Skills Inventory for Students (ASSIST) and examination grades, to investigate 'the relationship between course experience and approaches to learning, and to examine their relative importance as predictors of academic achievement.' They found that a model, which assumed course experiences factors could predict the students' approaches to learning, was supported. The same model however did not provide evidence for any indirect or intermediary effect between course experience, approaches to learning and academic achievement.

Struyven et al. (2006, p.279) reports on a study which investigated 'the effects of the learning/teaching environment on students' approaches to learning.' The Approaches to Learning and Studying Inventory (ALSI) was used to collect pre-test and post-test data comparing a lecture-based setting to a student-activating setting from those within their first year of elementary teacher education. Struyven at al., found a clear distinction in the approaches of those who had experienced the lecture based and student-activating teaching/learning environments. The direction of change that was found however was opposite to the premise that student-activating instruction deepens student learning. The findings showed that the student-activating approach in this case had pushed students towards a surface approach to learning. This study shows therefore that when changing a teaching style/method, it should not be assumed that a particular learning approach will follow. Effort must be made to understand how students perceive the original, and the altered, teaching methods to gain a better understanding of how approaches might be affected.

An Assessment for Learning (AfL) environment is one which encourages students to take responsibility for the direction of their own learning (McDowell et al., 2011). The Assessment for Learning Questionnaire (the AfLQ) was developed at Northumbria University by staff involved in the Centre for Excellence in AfL (the questionnaire is included in McDowell et al., 2011). The full version of the AfLQ includes an 'approaches to learning and studying' section, providing data on the quality of students' learning, and a module experience section, addressing features of the module related to AfL. The

questionnaire uses a five-point Likert response scale. All of the questions in the approaches to learning and studying section of the AfLQ (Section 1) are drawn from existing questionnaires developed and used by the Edinburgh ETL project team (ETL-Project, 2001-2005) and are thus questions which have been extensively tested in a number of research projects. Results indicate that the overall student experience is more positive in modules where assessment for learning approaches are used and students are more likely to take a deep approach to learning. Students who scored more highly on the deep approach were more positive with regard to staff support and module design and reported a higher level of engagement with subject matter. A surface approach to learning was negatively related to staff support and module design and engagement with subject matter for both kinds of modules. Higher scores on effort and organisation of study correlated positively with the staff support and module design; engagement with subject matter and peer support factors.

Quizzes or concept inventories are another method of investigation. They are primarily used to probe student understanding of basic concepts in engineering (using the format of multiple choice questions with students having to explain their reasoning) and also offer feedback to teaching staff on students' progress (Kautz et al., 2005). Concept inventories are aimed at rapidly assessing conceptual knowledge. The Force Concept Inventory (Hestenes et al., 1992) is a diagnostic test that was developed to identify whether or not students had understood the key concepts following their instruction. Other inventories have been developed including the Thermodynamics Concept Inventory (Midkiff et al., 2001), and also the Study Skills inventory (Tait and Entwistle, 1996) which identifies students at risk through ineffective study strategies. Although concept inventories are now more widely used Hestenes et al (1992, p.14) do recognise that 'knowledge about the nature and the extent of student misconceptions is insufficient by itself to improve the effectiveness of instruction'.

2.3.3 Summary of Investigating Learning Section

There are a variety of methods and instruments used to collect data within teaching and learning; more recently inventories have shown to be predominant when investigating the study patterns of group of students in higher education.

It has been identified that there is room to investigate the beliefs and actions of individual students in particular course settings. The complexities surrounding student evaluations are acknowledged. However, it is still considered that obtaining a student view on their experiences of teaching and learning can be largely beneficial to developing a greater understanding of the learning within a particular context.

There are an overwhelmingly large number of existing questionnaires and inventories. A few of the inventories and questionnaires have influenced this research specifically. The CEQ and the ALSI have provided useful examples of instruments, and the recent ETL questionnaires (the LSQ and the ETLQ) have been particularly useful in supporting development of questions about approaches to learning and orientation towards studying. The ETLQ specifically has shown how questionnaire items can focus on specific course units.

The main drawback considered with using these existing instruments as a method for evaluation of teaching and learning on their own is that there is often little opportunity for students to reflect on specific elements of the teaching and learning context which would in turn support the interpretation and analysis of the data. The student satisfaction method is considered to be a good example of how data collection methods can be combined to better understand teaching and learning.

2.4 Conclusion: How this thesis can contribute to the literature

Currently engineering education research has a broad focus on issues such as fundamental concepts and misconceptions, in addition to there being 'approaches to learning' research in sub-sets of the engineering discipline e.g. electrical or chemical. Hegarty-Hazel and Prosser (1991, p.421) highlight that reviews of research into students' conceptual scientific knowledge have suggested that 'future studies should go beyond identifying and describing students' conceptual knowledge'. They state that there should be more focus on the student learning characteristics related to the development of better conceptual knowledge

The literature discussed in this chapter has been used to establish a framework in which this research project is positioned. As a field of research engineering education is lacking studies which move the discipline forward by applying knowledge from generic teaching and learning literature and show consideration of the literature with respect to the discipline.

This chapter has demonstrated that there are still unknowns about the broad context of learning in mechanical engineering, how the students approach their learning and how they are influenced by their teaching and learning context. This thesis therefore will address these unknowns to provide information which can be used to inform mechanical engineering environments which focus on developing students' quality of learning.

A blend of qualitative, quantitative and mixed methods have been used in engineering education research however the work focusing on teaching and learning has predominantly focused on evaluation through questionnaires or inventories. Whilst there

have been context specific investigations which have considered teaching and learning, there is little evidence of these in undergraduate mechanical engineering. This further highlights the need for the research undertaken in this thesis.

In summary, this literature review highlights the need for context and discipline specific research, which explores students' perceptions and practices within a 'normal' programme of study.

3. Method Selection

3.1 Approaches to Research

Tashakkori and Teddlie (1998) outline three approaches to research these are, quantitative, qualitative and mixed methods. Armitage (2007) describes how quantitative research employs strategies of inquiry such as experimentation and survey, with methods of data collection that are pre-determined measures resulting in numeric data. Armitage explains that in contrast, the qualitative approach utilises methods such as case study or narrative which results in textual data.

Johnson and Onwuegbuzie (2004, p.14) discuss mixed methods, and state that 'the time has come' for this approach to research. The goal of mixed methods research is not to replace qualitative or quantitative approaches, 'but rather to draw from the strengths and minimize the weaknesses of both in single research studies and across studies' (Johnson and Onwuegbuzie, 2004, p.14). Tashakkori and Teddlie (2003) believe that there are three areas where mixed methods are superior to a single method approach: they provide the ability to answer research questions that other approaches cannot (confirmatory and exploratory questions); they provide stronger inferences through depth and breadth; and finally they provide the opportunity to express differing viewpoints.

3.2 The Design of this Study

Brannen (2005) outlines the rationales that underlie the choice of method in research designs as the 'three Ps': paradigms, pragmatics and politics. This study was developed pragmatically, with the research question influencing the study design. The nature of the research questions themselves required a method which allowed the detailed exploration of the experiences of individuals to understand, that is, what elements of the teaching and learning context are important to them, how they go about the practice of studying and what approach they take to their studies. To allow the study to address the aims, a method was required which, in addition to understanding the detailed experiences of a sample of students, could also, from an operational perspective, allow the findings to be considered across the cohort.

As discussed in Chapter 2, there are a range of existing instruments designed to explore particular aspects of the research question such as 'experiences of teaching and learning', 'approaches to learning' and 'perceptions of learning'. Whilst acknowledging that these instruments do exist, it was considered that as a stand alone method the use of an existing instrument would not allow the research aims of this project to be met. As perceptions and approaches are inevitably intertwined with the context of teaching and

learning it is felt that these standard questionnaires (whether all quantitative or a mix of qualitative and quantitative questions) limit the opportunities to explore the research question with regard to the context the students are in.

It could be suggested that a qualitative study would be more suitable; allowing individual's experiences to be explored through interview and interpreted by the researcher to form an understanding of an individual's unique experience. While this approach would go some way to answer the research question, it was felt that it would lack a practical element. Since qualitative studies usually have a smaller sample size than quantitative studies, it would be difficult to obtain findings which could be considered to be representative of the whole cohort in this context.

As the limitations of quantitative and qualitative methods have been highlighted, a *mixed method* research methodology is therefore most applicable in this instance. Creswell and Garrett (2008, p.322) give a working definition of mixed methods as an 'approach to inquiry in which the researcher links, in some way (e.g. merges, integrates, connects), both quantitative and qualitative data to provide a unified understanding of a research problem (adapted from Creswell & Plano Clark, 2007)'. Libarkin and Kurdziel (2002, cited in Levin and Wagner, 2009, p.218) suggest that 'qualitative analysis provides the context lacking in quantitative research and that quantitative analysis widens the implications of a purely qualitative study'. Most significantly, they claim that such studies can guide practice for both the local education setting and the wider context.

3.3 Philosophical Foundation and Paradigms

Paradigms may be defined as the worldviews or belief systems that guide researchers (Guba and Lincoln, 1994). They are considered to be an integral part of the research design considering that every researcher brings to his or her research a 'set of interlocking philosophical assumptions and stances' (Greene and Caracelli, 1997, p.6). Mackenzie and Knipe (2006) explain that there are a number of paradigms that are discussed in the literature and list the paradigms as 'positivist (and postpositivist), constructivist, interpretivist, transformative, emancipatory, critical, pragmatism and deconstructivist'.

According to Mertens (2005, p.7) a 'researcher's theoretical orientation has implications for every decision made in the research process, including the choice of method'. Quantitative methods are underlined by the positivist paradigm, while qualitative methods are underlined by the constructivist paradigm (Tashakkori and Teddlie, 1998). Pragmatism supports the use of both qualitative and quantitative research methods in the same research study and within multistage research programs. Pragmatism is

proposed by several authors and cited by Teddlie and Tashakkori (2003, p.20) as ‘the best paradigm for justifying the use of mixed methods research’.

3.4 Pragmatism

This research has been grounded in the pragmatic paradigm. Teddlie and Tashakkori (2003, p.21) explain that ‘pragmatist researchers consider the research question to be more important than either the method they use or the paradigm that underlies the method’. It is suggested that for those interested in understanding the experiences of students and staff in engineering education then pragmatism provides a sound foundation for research. It also supports research which can be used to inform future practice and decisions within the discipline.

Johnson and Onwuegbuzie (2004) stated that those who conduct mixed methods research are more likely to select approaches, and methods, with respect to the research questions, rather than with regard to predetermined views about research paradigms. Pragmatism has been described as the ‘philosophical partner’ for mixed methods’ as it ‘rejects the either-or choices from the constructivism-positivism debate’ (Teddlie and Johnson, 2009, p.73). Pragmatism can be considered to provide a third choice; one which takes consideration of real-world circumstances and the research question.

Pragmatism aims to interrogate a particular question or theory rather than find causal links. Many of the knowledge claims for pragmatism arise out of ‘actions, situations, and consequences’ where, ‘instead of methods being important, the problem is most important, and researchers use all approaches to understand the problem’ (Creswell, 2003, p.10). Pragmatist researchers focus on the 'what' and 'how' of the research problem (Creswell, 2003, p.11). The research question is 'central' with data collection and analysis methods chosen as those most likely to provide insights into the question with no philosophical loyalty to any alternative paradigm (Mackenzie and Knipe, 2006).

The notion of pragmatism can also be applied to the concept of transferability. Morgan (2007, p.72) suggests an advocacy of transferability which arises from a ‘solidly pragmatic focus’, considering that in each specific situation people should think about how they can use knowledge produced, rather than assuming transferability based on abstract arguments about generalisability. As this research will be heavily context bound, transferability is not assumed; findings will be considered on their own merits to determine whether any of them have an element of transferability.

3.5 Mixed Methods Research

Tunnicliffe and Moussouri (2003, p.3) explain that not all aspects of peoples' understanding can be revealed by a single method, which is why researchers 'need to be clear what it is they want to assess and to use a mixture of appropriate methods...'

Creswell (2003) makes the assumption that bringing together qualitative and quantitative data can lead to a better understanding of research problems than either approach alone. The approach is one in which the researcher tends to base knowledge claims on pragmatic grounds (e.g. consequence-oriented, problem-centred, and pluralistic). Mixed methods research has a range of strengths. It is particularly useful in survey, evaluation, and field research (Patton, 2002) because it has a broader focus than single method design and gathers more information in different modes about a phenomenon (Giddings and Grant, 2006).

According to Gorard (2004), combined methods research has been identified as a 'key element in the improvement of social science, including education research' (p.7) with research strengthened through use of a variety of methods. Gorard suggests that although this method of research requires skill, it can 'lead to less waste of potentially useful information', and often has greater impact because figures can be very persuasive to policy-makers, whereas stories are more easily remembered and repeated by them for illustrative purposes' (p.7). Ary et al. (2009, p.559) do acknowledge that there can be 'concerns about the time and expertise necessary to combine quantitative and qualitative research within one study'. This is a limitation accepted in this thesis and will be addressed through the careful time management required to conduct the research in-line with the academic year, and through additional researcher training which will be undertaken.

3.6 Mixed Methods Research Designs

Bergman explains that there are two main characteristics which emerge from mixed methods literature: the concurrent design with aims to bring together qualitative and quantitative data in parallel, or the sequential design which uses one type of data to extend or build on the other (Bergman, 2008, p.66). In concurrent designs, both forms of data are collected at the same time and then integrated to make possible the interpretation of the overall results (Creswell, 2003, p.P16). This model generally uses separate quantitative and qualitative methods to offset any weaknesses within one method with the strengths of the other method. Sequential timing occurs when the researcher implements the methods in two distinct phases, using (collecting and analysing) one type of data before using the other data type (Creswell, 2003). Both combinations are possible; either collecting qualitative data first, or collecting quantitative data first. Sequential approaches are useful when a researcher needs one

data set initially to inform a subsequent activity such as designing an intervention, selecting participants or to develop an instrument (Creswell, 2007).

Within the different design types there are multiple combinations which vary slightly within the literature. Creswell et al. (2003) propose four types of mixed method design, with combinations of qualitative and quantitative data collection in explanatory, exploratory, transformative or nested designs. The type of design will be influenced by the reasons for choosing a mixed method design initially such as a) to enable confirmation or corroboration via triangulation b) to elaborate or develop analysis, providing richer detail, and c) to initiate new lines of thinking through (Rossman and Wilson, 1991). Hanson et al. (2005) agree that another reason to use mixed methods investigations may be to identify variables/constructs that may be measured subsequently through the use of existing instruments or the development of new ones.

Decisions need to be made in mixed methods designs about the priority, and integration of the data (Creswell et al., 2003). Priority refers to which method, either quantitative or qualitative, is given more emphasis in the study. Integration refers to the phase in the research process where the mixing or combining of quantitative and qualitative data occurs (Creswell, 2003). Data analysis and integration may occur by analysing the data separately, by transforming them, or by connecting the analyses in some way (Tashakkori and Teddlie, 1998).

3.7 Selection of Mixed Method Sequential Exploratory Design

This research seeks to understand the experiences and practices of second year mechanical engineering students, and, as this is an under-researched area, a research design was needed that could allow new themes to emerge. A research design was also needed to explore learning and teaching under the theoretical framework of existing scholarly work which considers approaches and perspectives in learning; therefore a mixed methods sequential exploratory design was chosen.

The intent of the two-phase exploratory design (see Figure 8) is that the results of the first method (qualitative) can help develop or inform the second method (quantitative) (Greene et al., 1989). This design is based on the premise that an exploration is needed for one of several reasons: measures or instruments are not available, the variables are unknown, or there is no guiding framework or theory. This design has two common variants: the instrument development model and the taxonomy development model (Creswell and Plano-Clark, 2007). A design which begins qualitatively is best suited for exploring a phenomenon (Creswell et al., 2003). This design is particularly useful when a researcher needs to a) build a new instrument because a suitable one is

not available or b) identify important variables to study quantitatively when the variables are unknown (Creswell et al., 2003). It is also appropriate when a researcher wants to generalise results to different groups (Morse, 1991), to test aspects of an emergent theory or classification (Creswell and Plano-Clark, 2007).

Figure 8 shows the mixed methods notation of an exploratory sequential design. The uppercase notation of 'QUAL' is used in the figure to indicate that the qualitative source would be dominant. The lowercase 'quan' shows the less dominant, quantitative source, which is used for expansion and elaboration purposes.

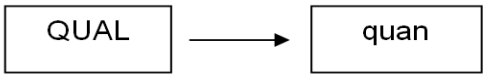

Figure 8: Exploratory sequential design overview (Creswell, 2003, p.213).

Morse (1991) introduced the 'QUAL' and 'quan' notation in a paper which also explained that there cannot be equal weight to qualitative and quantitative aspects of a research project, 'a project must be either theoretically driven by the qualitative methods incorporating a complementary quantitative component, or theoretically driven by the quantitative method, incorporating a complementary qualitative component.' Although the qualitative phase is dominant in this design the presence of the quantitative data can actually make the 'qualitative approach more acceptable to quantitative-based audiences' (Creswell and Plano-Clark, 2007, p.78).

3.8 The Instrument Development Design

The 'Instrument Development Model' is the variant of the exploratory sequential design used in this study. The instrument development model is used when there is a need to develop and implement a quantitative instrument based on qualitative findings. Saldana (2009) describes the value of codes in mixed methods studies and for this purpose, Creswell and Plano-Clark explain that quotes, statements or codes derived from data in one stage can be used in a quantitative follow-up (Creswell and Plano-Clark, 2007).

Within an exploratory sequential design 'the in-depth knowledge of social contexts acquired through qualitative research can be used to inform the design of survey questions for structures interviewing and self-completion questionnaires' (Bryman and Bell, 2007, p.618). A new finding can be treated as an indicator which 'does not have to be completely verified itself,' instead it may be 'verified or confirmed elsewhere in another data set' (Tashakkori and Teddlie, 2003, p.195).

In this research project, the research topic is initially explored qualitatively with a limited number of participants (Creswell and Plano-Clark, 2007). Themes and specific

statements are obtained from participants during the first phase of data collection before being turned into specific items for a survey instrument to be used in the second phase to explore the initial findings with a larger sample (Creswell, 2003).

Creswell and Plano-Clark (2007, p.124) cite some considerations for instrument development which were provided by DeVellis (1991); these include determining 'what you want to measure' and grounding 'yourself in theory and in the constructs to be addressed (as well as in the qualitative findings)'. These have been kept in mind during this study.

3.9 The Mixed Method Sequential Exploratory Design in this Study

The existing theoretical framework (as discussed in chapter 2) is used as a guide for the qualitative phase of this research. The qualitative results are then used to directly inform the quantitative phase. This two-phase, mixed approach, enables any ideas emerging from the qualitative data (which may, or may not, be context specific) to be followed up quantitatively. While quantitative testing is the second component, the overall theoretical thrust of this research is inductive (Morse, 2003).

In the case of this research question it is accepted that the context is unique in this instance; experiences of students will be different in different institutions and students will all bring with them their unique prior experiences and understandings. It is suggested that the exploratory design implemented in this research could be applied in other institutional settings to allow a more detailed understanding to be developed of students' experiences of teaching and learning in mechanical engineering in the UK. It is advised that whilst the design is transferable, the particular instrument which is developed cannot be taken in its entirety to new research settings without allowing for appreciation of any particular features of the new context.

Figure 9 shows further detail of the sequential stages undertaken during this project to develop an understanding of students' perceptions, practices and approaches to learning.

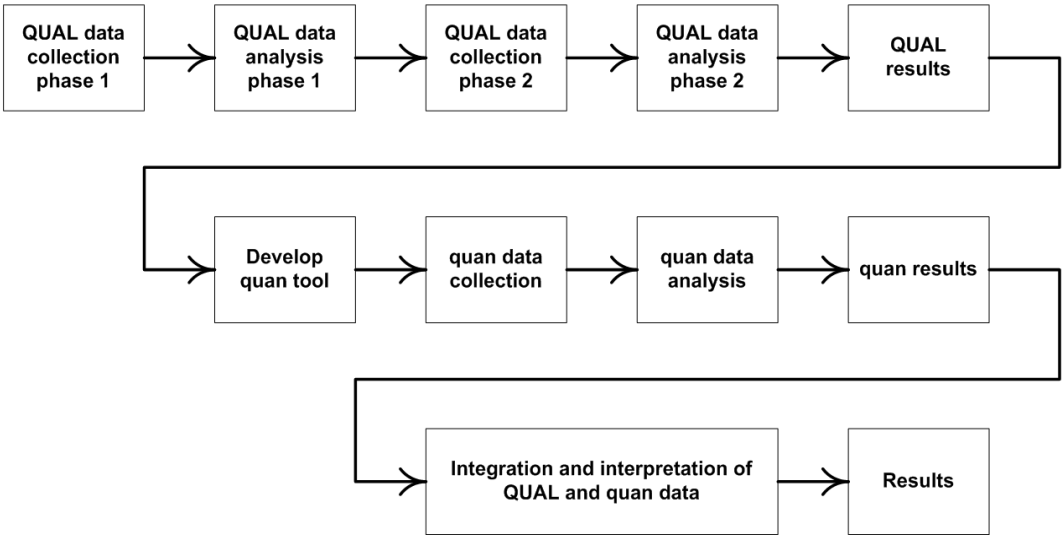

Figure 9: Sequential stages of the research. Adapted from the exploratory sequential design (Creswell and Plano-Clark, 2007, p.58).

3.10 Conclusion: Research Design

This chapter has explained the design of the study. The reasoning to ground the study in the pragmatic paradigm is given, and the detail of the specific mixed methods design is presented. This thesis has strongly followed the existing frameworks of the mixed methods research field, and is an example of a study which strictly follows the principles within mixed methods research.

4. Research Process

This chapter is designed to explain the way in which the data collection and data analysis within this research was carried out. The actions are explained in a sequential manner; in line with what actually happened, and in the order that it occurred.

4.1 The Programme at the Focus of this Research

The programme which forms the basis of this research is an accredited programme in a post-92 university in the UK. The BEng (Hons) Mechanical Engineering programme is a three year full-time undergraduate course, or a four year part-time course. It can also be taken as a sandwich course over four years, where three years are full-time study and one year is a work placement (occurring during the third year of the programme). The cohort numbers on the second-year modules during the time of the study were 73, with 54 full-time students and 19 part-time.

The research is specifically focussing on investigating the learning of second year students. It is at this stage during the programme where the teaching moves away from attempting to cover the broad, basic level knowledge of the subject and into the more complex, conceptual ideas, and problem solving. The programme of study in second year is made up of seven modules: five which are year long, and two which are only semester long. Themes run through the years of study including, subjects in Mechanical Sciences, Energy Studies, Design, Materials and Manufacture, Mathematics and what are known as Supporting Studies (such as Communication, Professional Skills, Instrumentation). All the modules are taught by staff in the Mechanical area with the exception of Maths which is 'service-taught' by a member of the Maths department. The two figures in appendix E illustrate the full-time and part-time programme, and the modules within them. During the first and second years of study, students on this programme are not offered any options as to what they study; all modules are therefore compulsory and can be deemed to be core to the programme. A more detailed explanation of the context of the curriculum in which the sample was involved is explained in also given in appendix E.

Generally, students are taught in two, 12 week semesters. Students are all issued with a programme handbook at the start of each academic year which explains the programme details. In second year, students tend to have 12 hours of lectures a week with additional labs and seminar sessions. Students may have between two and six hours of labs a week depending on the time of the year and the lab schedule. Part time students tend to have 10 or 11 hours of study, one-day per week.

Seminar sessions are used in some subjects as a supporting mechanism to lectures, seminar classes tend to be smaller and students can request help on specifics. Where seminars are not used, staff are expected to ensure that their lecture time is interactive so that students still get the chance to try out activities and ask any questions they may have. Laboratory sessions generally complement a lecture series, and allow students to apply some of the theory that has been discussed in class (or in some cases, familiarise students with the practice before the theory is discussed). Seminars and/or lab sessions both generally allow students the opportunity to discuss problems with staff in smaller groups and to ask for help in curriculum areas if needed.

Students are currently able to offer feedback on their experiences in three main ways. Each module is evaluated at the end of the academic year using a standard questionnaire format which asks students to comment on positive and helpful aspects of the module, negative or less-helpful aspects. It also asks students to rate the overall quality of a module. Student Representatives are nominated for each year of study on every programme. Student reps are invited to 'Staff Students Liaison Committee' (SSLC) meetings twice in an academic year whereby they can feedback any concerns to staff that they or their peers have. This gives staff a chance to respond to any concerns during the year rather than waiting until the end of the academic year before receiving feedback and acting on it too late for it to be of benefit to students. In addition to this, staff may seek informal feedback from students during the year or take assessment marks as an indication of learning within a class.

4.2 Sampling: the Programme and the Participants

Sampling is used when it is not possible, nor practical, to include the entire research population in a study (Pickard, 2007),

In order to best inform and address the research question, purposive convenience sampling was used to obtain the initial sample frame for the research. The sample was available to the researcher through the nature of the study being based at the UK University where the researcher was employed. Selecting the Mechanical Engineering degree in this way is a matter of 'intentionally selecting specific cases that will provide the most information for the questions under study' (Kemper et al., 2003, p.279).

The procedure for selecting participants was also an example of purposive convenience sampling; all students in the cohort were invited to participate in interviews and to complete the questionnaire. Although all students were invited to participate, students self-selected whether to be involved (students that were absent were not included in the invite to provide quantitative data).

It is accepted that convenience sampling in this manner differs from use of an ideal sample; there may be students who are not represented, through absence or through declining to be involved. The sequential nature of this study (which explores the themes identified in the qualitative research with a larger sample in the quantitative study) is intended to reduce the likelihood of neglecting or under-representing students within the cohort. This method however can still not account for students who may be absent, or may chose not to be involved in data collection during the quantitative stage. This method seeks to explore the research question within the practical limitations of social research and aims to obtain relevant findings without assuming that all individual views can ever be fully represented.

The sample sizes used were larger in the quantitative phase than the qualitative phase. This follows the example of sampling within mixed methods by Creswell. et al. (2008, p.75) where unequal sample sizes are used 'in the quantitative and qualitative strands of a study for the purpose of providing a full picture of the situation.' Samples in this study are from the same population. In this case, where students perceptions are being explored in a context bound manner, it would not be suitable to use samples from any other population as the context would differ.

Full-time and part-time students agreed to be in both phases of the research. Of the 54 full time students and 19 part time students, 56 opted to be involved in quantitative study and 14 opted to be involved in the initial qualitative study.

4.3 Consent

Information sheets (appendix F) were given to all students involved in the project and the project was also explained verbally and via email. All students who agreed to be interviewed and/or completed the questionnaire were asked to sign a consent form to confirm that they agreed to their data being used for the purposes of this research (appendix G). It is understood that anonymity of the research participants cannot be promised as their identities were known to the researcher, however their confidentiality could be provided, since their identity will not be revealed at any stage (Pickard, 2007).

Before the study began, discussion took place with the module tutors for classes in which there would be data collection. Their agreement that this could happen was crucial to the research since any quantitative information gathered or requested from students would take place during the normal lecture time (usually in the last 5-10 minutes).

4.4 Ethics

Ethical approval from the University was received for this project. The ethics approval process involved submitting a research proposal for consideration by a Research Ethics Committee, in line with the University ethics approval process.

Acknowledgment has been given that the presence of a researcher may have had some effect on the staff/students involved in the research. The presence of the researcher in several teaching sessions, and the use of triangulation in data collection, enabled a reliable picture to be formed of what the students experience in a normal cycle of delivery.

Information collected as part of this research is stored in a lockable cabinet within a lockable room: the room is always kept locked when unoccupied. The computer used is password protected and electronic data is only be available to the researcher and is not be stored on a shared database.

When interviewing students, the project was explained again, and a second consent form was used to ensure students understood that their quotes may be used in the write-up of the research (and reminding them that all information would be anonymised). It was explained to students that they were free to withdraw from the research at any time

A further ethical consideration was the need to keep data obtained during the research entirely from the staff involved in the programme. It was not the purpose of this research project to offer feedback on individuals' teaching or to highlight possible areas of weakness as identified by students. Ethically, it was considered that individual bites of data, which could either encourage staff to change their practice, or cause staff to feel that they were being judged, should not be disclosed during the course of study. For the purpose of the research, all data collection had to be carried out with as limited influence on the research site as possible. Module tutors were very understanding; they were willing to allow research to take place during their teaching time and space, and accepted that the information being obtained from the students was only to be used for the project.

4.5 Preliminary Qualitative Data Collection (Pilot Phase)

The dominant phase within the project was the qualitative phase, informed by literature and findings from a pilot study. The pilot looked to explore students' perceptions of their teaching and learning context, to identify aspects of students' approaches to learning, and (from a practical point of view) the practices students undertook to learn. The pilot study was conducted making use of observations, two focus groups and eight semi-

structured interviews with second year students from the previous cohort (second year students, 2008-2009) to explore the research question.

Observations were used to collect data in 'as holistic and naturalistic a manner as possible' (Foster, 2006), giving information about the physical environment and about human behaviour directly without having to rely on the retrospective accounts of others. Observations in lectures provided gave data on the environment and behaviour of those who agreed to be observed but who did not want to take part in interviews. There are limitations to observation as a research method; 'behaviour of interest may be inaccessible and observation may simply be impossible' (Foster, 2006). This was found to be the case in seminars, where students worked individually or in pairs on written questions, making observation of student processes difficult when remaining unobtrusive was key. It was therefore decided that further seminars would not be observed. People may change the way they behave during observations but observations were made over a whole academic year (in a limited number of modules) therefore it was expected that any behavioural changes would not have lasted this entire period. The purpose of the observation of sessions was to:-

- Observe which delivery techniques are used most frequently, which form of assessments have the most emphasis put on them and how frequently informal/ formative assessment techniques are used in the classroom.
- Allow the researcher to observe how students behave i.e. how they respond to questions, engage in discussion, when they ask questions.
- Allow the researcher to further understand the programme and to help frame the interview questions.

The interview questions in the pilot phase were developed from the Experiences of Teaching and Learning questionnaire (this was supplied by the Centre for Excellence in Teaching and Learning: Assessment for Learning, and later published in McDowell et al., 2011) and from knowledge of the second year engineering programme structure. Questions were also informed by observation of classes which allowed qualitative data to be gathered regarding delivery techniques, relationships within the classroom and students' participation and engagement in their learning.

Results from the pilot study were analysed based on a-priori codes identified from teaching and learning literature and using emergent codes which developed during the analysis. This allowed aspects of the teaching and learning context pertinent to the students to be described by seven main themes: Environment, Social Aspects of Learning, Structure/Organization, Student Motivation, Subject Demands, Students Perception of Staff and Problem Solving. Within the main themes, several emergent

factors were highlighted such as the occurrence of peer working, the engagement in questioning behaviour and the use of resources. It was these themes that would be followed through into the main qualitative phase.

4.6 Main Qualitative Phase

The main qualitative phase was informed by the pilot data (which provided an insight into the context students were emerged in) and by existing studies (such as ETL-Project, 2005 and McDowell et al., 2011) to determine what aspects of the teaching and learning context may be influencing the perceptions of the second year students and how they were practicing and approaching their learning.

The first round of interviews took place at the start of the first semester. The timing of the interviews was crucial to allow for recent reflections on students' first year experiences and to capture their aims for the second year. They were conducted in a neutral location away from the engineering department. The questions asked focused on exploring the individual's previous experience, their aims, motivations for taking the course and their academic achievements in previous years. Students' approaches in previous years of study were discussed so that any changes in approaches could be discussed in the second stage of questioning. From a practical point-of-view, student practices and behaviours were discussed including organisation, attendance, assessment preparation, independent reading, etc. Students were asked what had helped them learn in the past, so that an attempt could be made to understand their perceptions about what they felt had been helpful and what they had found to be unhelpful. They were asked what it meant to them to learn and how they could tell if they had learned something. Their interactions with lecturers and peers were explored, as were their information seeking/questioning behaviours. An example interview schedule is shown in appendix H.

Interviews explored students' expectations with regard to the subjects that they consider to be important. The demands on students were discussed, such as, what students felt they needed to do to pass and which subjects they thought required the most work. Assessment was discussed, asking students which types of assessment they prefer and which helps them most to learn. Students were also asked to identify what the university could do to support them more.

In the second round of interviews similar themes were explored. The semi-structured interview format was based on the common themes from round one, the Shortened Experiences of Teaching and Learning Questionnaire (ETL-Project, 2005) and individual student responses from the first round. Students were asked to consider their progress

during the year and whether their motivations and aims had remained the same. Students' perceptions of the teaching and learning context were also explored. Aspects of the context which were discussed included course structure, nature of the discipline, institutional/course factors such as scheduling/timetabling, interactions with staff, assessment, workload and resources. Students' approaches and practices were discussed in relation to the aspects of context. Furthermore, students' independent study activity was explored, in addition to their approaches to studying in classes and their practises in relation to assessed tasks.

4.7 Qualitative Data Analysis

Bradley et al. (2007) assert that 'there is no singularly appropriate way to conduct qualitative data analysis.' They do recognise that there is general agreement that the analysis process is a recurring one, which begins in the earlier stages of data collection and continues throughout. The analysis of the qualitative data in this study was required to take place immediately after each stage of qualitative data collection. Analysis of the first phase transcripts was needed before the second round of interviews could commence and therefore before the whole qualitative data collection phase could be completed. Following the second qualitative phase, further analysis was required; the interview transcripts were entered into the QSR NVivo data management program on each occasion, so that a comprehensive process of data coding and identification of themes could be undertaken.

The qualitative data was explored through the use of thematic analysis, searching for themes which emerged and were important in describing the phenomenon (Daly, Kellehear et al., 1997, cited in Fereday and Muir-Cochrane, 2006). Repetition, metaphors and analogies, transitions, similarities and differences, linguistic connectors, missing data, and theory-related material were considered when searching for themes (Ryan and Bernard, 2003).

Miles and Huberman (1994) also see coding as part of the analysis process. The method of coding that was used in this study was a hybrid of inductive and deductive approaches as described by Fereday and Muir-Cochrane (2006), where inductive themes were identified and grounded in the data and deductive themes were derived from the philosophical framework. Allowing codes to develop inductively avoids the danger of forcing data into pre-existing codes (Bradley et al., 2007). Descriptive coding was used in both the inductive and deductive coding process. This coding tended to consist of one or two words which summarised the principal topic of the extract (Saldana, 2009), although in some cases several words have been used. During

coding, classification reasoning was used plus the notion of whether data 'looked alike' or 'felt alike' (Lincoln and Guba, 1985).

In a similar manner to Fereday and Muir-Cochrane (2006, p.86) 'content analysis was not the aim of the data analysis' in this study. This allowed a single comment in the qualitative data to be considered 'as important as those that were repeated or agreed on by others within the group' and be taken forward to the next stage. This technique was particularly useful within this mixed methods study; it allowed interesting comments made by individuals to be explored within the larger quantitative sample to determine if they held true for the majority of students.

4.8 Quality in the Qualitative Research

Brannen (2005) recognises some of the difficulties in defining the quality criteria for mixed methods research and questions whether we should work to existing criteria or whether we should develop specific criteria. In quantitative research, quality concepts such as generalisability, validity, reliability and replicability are identified (Spencer et al., 2003, cited in Brannen, 2005). Broadly equivalent concepts for qualitative research are identified by Brannen as credibility/ trustworthiness, fittingness and auditability.

As Bryman (2006) suggests the quality criteria which is used is 'likely to depend upon the dominance of the qualitative or quantitative method and type of data analysis used within the project'. In this project, the qualitative component is dominant and therefore in the initial analysis, the quality concepts related to this category of data will be considered.

Attention to data collection strategies and quality has been given at every step of the process to ensure a rich understanding of the research topic. The range of methods and approaches used to ensure quality are outlined in this chapter.

Credibility in research 'depends on (1) rigorous methods, (2) the credibility of the researcher, and (3) philosophical belief in the value of qualitative research' (Patton, 2002, cited in Cottrell and McKenzie, 2011). 'Reliability and generalisability play a relatively minor role in qualitative inquiry' (Creswell, 2003, p.195) however validity is seen as strength of qualitative research. It is used to suggest whether findings are accurate from the standpoint of the researcher, the participant, or the readers of an account (Creswell and Miller, 2000). Terms used in the qualitative literature, such as 'trustworthiness,' 'authenticity,' and 'credibility' (Creswell and Miller) reflect this perspective.

Rigor in qualitative research refers to employing a systematic approach to research design, careful data collection and analysis, and effective communication (Mays & Popo, 1995; Patton, 1999, cited in Cottrell & McKenzie. 2011). This influenced the planning stages of the research and ensured the research design was appropriate to address the research question. It informed the timing of the research stages and the organisation of the interaction with the students.

A procedural perspective recommends making use of available strategies to check accuracy of findings (Creswell, 2003). Validity in qualitative research lies in the reader being convinced that the researcher has accessed and accurately represented the data (Cottrell and McKenzie, 2011). Various methods can be used to increase credibility such as rigorous data collection and analysis. Other methods include prolonged engagement; persistent observations; rich, thick description; triangulation; peer debriefing; self-reflection (clarifying researcher bias); member checks and external audits (Creswell, 2003).

Thick, rich descriptions are used to explain the research context and the qualitative findings in this research. This is to allow the reader detailed access to the research setting to aid in the understanding and interpretation of the data. In terms of the analysis, data is presented showing positive and negative aspects of the student learning experience. The data includes responses to planned questions but also findings which emerged as the questioning developed during the interview process.

The level of detail provided in the process and results chapters of the thesis is included so that readers may consider the suitability of the results to be transferred to other populations in similar settings (Malterud, 2001).

The degree or level of truth of participant responses also increases the validity of the study. Developing trust and building rapport between the researcher and research participants can accomplish this (Cottrell and McKenzie, 2011). In this research prolonged exposure of the participants and the researcher helped to establish a rapport. Through observation of sessions and by conducting a second interview with students, a relationship was able to develop'. Pilot testing of the interview questions supported the development of a rapport with students during the actual research phase, ensuring that questions were relevant and well-phrased.

Lincoln and Guba (1985) discuss how a confirmability audit, or audit trail, can by used to demonstrate the neutrality of research interpretations. They suggest audit trails should consist of; raw data, analysis notes, reconstruction and synthesis products, process notes, personal notes and preliminary developmental information. An auditable record trail is being kept during the process of the research, with research data including

interview transcripts and coding (excerpt in appendix I), observation records (example in appendix J), and documentation of the analysis procedure (as described in this chapter). The documentation demonstrates the neutrality of the research interpretations and evidences the original interview transcriptions, showing quotations in their original context. This proves that quotes were taken as they were meant and meanings were not altered as they were selected and removed from their full context.

4.9 Progression from Qualitative Phase to Quantitative Phase: Developing the Quantitative Tool

A quantitative tool was required to explore the qualitative findings with a larger sample. By exploring the data within a larger sample, it was possible to extend the detail of the findings and ensure research aims were being addressed.

The decision was made to develop a questionnaire as the data collection instrument. The questionnaire is a 'highly structured' data collection instrument (Wilson and McClean, 1994, p.7). As a tool the questionnaire provides a structured format to enable information to be obtained (Wilson and McClean, 1994).

The themes, codes and statements from the qualitative analysis, in addition to questions from the SETLQ questionnaire (ETL Project, 2005), were considered during the development of the items for the tool. A decision was made to make use of some of the already piloted questions from the ETL project. The SETLQ was divided into several sections where specific questions from the 'expectation of higher education' and 'approaches' section were considered. The questions in the 'approach' section were considered to align well with data obtained during the qualitative phase, and those from the 'expectation of higher education' section were considered to provide an additional level of detail which could support the context specific questionnaire items developed specifically from the qualitative data.

With 24 transcripts from the main study, the potential for developing items for the questionnaire became substantial. Following the coding of the data, each coded item from the transcripts had to be studied for the potential of being included as an item in the questionnaire. The codes were arranged into themes to make the overall thrust of data collected easily accessible. The consideration of the codes (and the related sections of text from the transcripts) provided an abundance of items which could be considered for inclusion in the questionnaire. Reduction of the items was required to develop a more succinct set of items which were in-keeping with the research question. The purpose of the questionnaire was to answer the research question by focussing on obtaining confirmation of the key issues from the qualitative phase of the study; it was therefore

important that whilst some of the peripheral information students supplied was interesting and potentially helped with interpretation of the research, it was not allowed to detract from the main purpose of the study by being included in the questionnaire. A summary of the development stages are outlined in Figure 10.

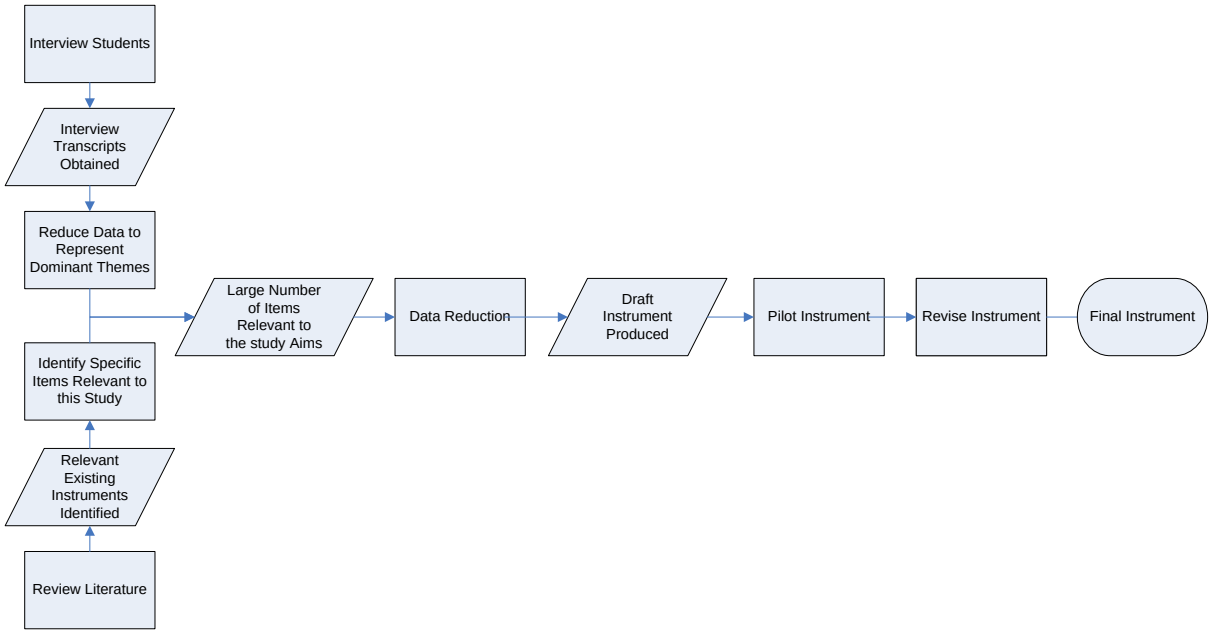

Figure 10: Developing the instrument.

There was also a practical drive to reduce the size of the questionnaire. Whilst acknowledging that a larger questionnaire might give more information, leading to a better understanding of the phenomenon, it might also discourage people from answering the questionnaire in its entirety. Care was therefore taken to avoid unnecessary duplication of questions whilst also retaining multiple items to explore variations from the qualitative data.

Quality of the questionnaire was kept in mind throughout. Tashakkori and Teddlie (2003, p.308) suggest that when writing a questionnaire you should understand your research participants and not use 'leading' or 'loaded' questions. They suggest making use of multiple items to test constructs and also advise that questionnaires should be easy for the participants to use and should always be pilot-tested. Simple, clear and precise items making use of familiar language were required.

There are primarily three types of questionnaire questions; behavioural, attitudinal and classification (Hague, 1993, p.23). In this project a combination of behavioural and attitudinal questions were asked. Behavioural questions were used to explore practises and approaches, whilst attitudinal questions were used to explore perceptions.

Refinement (with constant reference to the research question) continued until a draft questionnaire was prepared. The questionnaire was proof-read and piloted with a range of users; a discipline specialist, an information specialist and a student. The questionnaire could not be piloted with the student cohort due to the nature of the mixed method structure used in the study; there were considered to be a large number of questions which would not be applicable to anyone other than those students involved in the study and its individual context.

In the final instrument there were seven categories (written in participant-accessible terms) and 91 questions. Questions were presented as statements offering likert-type responses. This is usual in social research where the format for 'indicating level of agreement is a 5-point or 7-point scale going from 'strongly agree' to 'strongly disagree' (Bryman and Cramer, 2002). Within the 91 questions derived from the qualitative data, 16 were taken from the SETLQ section on 'approaches and expectations.' A further nine of the questions were adapted from the SETLQ as they very closely related to the information provided by students in the interviews themselves.

The final questionnaire had seven sections with headings as shown below (see appendix K for full questionnaire). Six of the seven category headings came directly from the analysis of the qualitative data. The seventh, regarding 'experience of HE', was taken from the SETLQ (ETL-Project, 2005). To make the questionnaire more accessible for students, the questions were arranged to fit on one sheet of paper.

The questionnaire section headings were:

- What do you expect to get from the experience of higher education?
- Approaches to learning and studying.
- Subjects & Classes.
- Ways of Learning.
- Assessments.
- University Structure and Staff.
- Personal.

4.10 Considering Validity and Reliability of the Quantitative Tool

A fundamental issue in questionnaire design is whether the instrument accurately measures what it is supposed to measure. This is considered in terms of a questionnaire's validity (if it measures what it sets out to measure) and reliability (judged on the consistency and stability of the responses) (Frazer and Lawley, 2000).

4.11 Validity and Reliability

Validity needs to be shown; it cannot be assumed to be built into an instrument. Creswell (2003) explains that there are actually three traditional forms of validity to look for in quantitative studies, these are content validity, criterion (predictive or concurrent) validity and construct validity. In this research, validity is considered initially in terms of content (or face) validity; whether at face value the questions appear to be measuring the content in question. Whilst this approach is acknowledged to be subjective, it is a 'useful first approach' in questionnaire design (Peterson, 2000, p.79). This approach is valuable since the opportunities to pilot the instrument are limited and there would not be an opportunity to re-administer the instrument or a follow up tool.

Two other forms of validity are recognised (construct and criterion) however they have not been applied to this research. Construct validity refers to the ability of the items to measure hypothetical constructs of concepts (Creswell, 2003) and as the data will not be reduced to constructs then this form of validity is redundant in this instance (see 4.12.2 for further detail on this decision). Criterion validity is assessed by considering the extent to which results from the questionnaire relates to other variables or constructs which can be considered comparable (Peterson, 2000). The context specific nature of the instrument means that it is not feasible to compare it to an existing instrument. It is also not viable to consider the instrument as a predictive tool since the item itself seeks to explore approaches and opinions at the current time and does not aim to predict actions which will take place in the future.

Three measures can be considered in relation to reliability; these are stability, internal reliability and inter-observer consistency. As there is only one researcher involved in this project, inter-observer consistency will not be considered with regard to the instrument development. Reliability refers to the consistency of a measure of a concept (Bryman, 2008). Reliability is especially important if the measure is to be used on an on-going basis, for example to detect change in opinion. As stated previously this will not be the case in this study due to the specific contextual nature of the instrument.

Internal reliability (or internal consistency) will not be explored as it directly refers to the presence of constructs produced from the data (Bryman, 2008). Reliability in terms of 'stability' refers to there being little variation in the results of a sample if the instrument is administered twice or more over a period of time. It is impractical to consider the stability of the instrument in detail as the context of the sample to which it is administered will change over time and therefore the responses will also be expected to change. This questionnaire will not be used again in its entirety; it will need to be informed by a qualitative phase first to ensure the elements of the specific context are

allowed for, or used as a basis and amended slightly to allow it to be relevant to another context.

4.12 Quantitative Data Collection

The questionnaire was administered during a normal timetabled lecture session and took students approximately ten minutes to complete.

4.12.1 Data Analysis Tool

The analysis of the data was carried out using the software SPSS. The responses were assigned numerical values with strongly agree indicated by a '1' through to strongly disagree indicated by a '5'.

Sample size should be considered when producing and computing statistics. There is a rule of thumb which suggests that the number of items of a questionnaire should less than the number of respondents to allow for generalisation to the population to be achieved (Bryman and Cramer, 2002). The purpose of the questionnaire in this study is to explore further, and expand on, the qualitative data obtained though the interviews. In this case the number of respondents is limited with the cohort size. The large number of questions were a result of the qualitative analysis (91 items in total) and being greater than the number of respondents means that, statistically, no attempt could be made to generalise to the population. The contextual nature of the study also dictates that the quantitative results are only valid in this instance however there are still lessons we can learn from the results overall which can be considered with respect to engineering education more generally.

4.12.2 Treatment of Data as Ordinal Data

Strictly speaking, the data produced from the questionnaire should be classed as *ordinal* data (Bryman and Cramer, 2002) since the difference between the responses on the likert-type scale are considered to have a relative rank-order which cannot be assumed to be equal.

There is ongoing debate in the literature as to whether the parametric tests used on interval data can also be used for ordinal data. Both work by Hensler and Stipak (1979) and Stevens (1946) suggests that there are benefits in assuming interval level data and conducting associated analysis. Bryman and Cramer point out however that when a variable allows only a small number of ordered categories, such as four or five categories, 'it would be unreasonable in most analysts' eyes to treat them as interval variables' (Bryman and Cramer, 2002, p.58). They observe that the case for treating

them as ordinal variables only becomes more compelling when the number of categories is considerably greater.

Although Doig and Groves (2006) explain that the usual course of action in educational research is to commute the means for raw ordinal data however purists tend to say that sum scores of multi-item assessments (the mean values), do not have an interpretable meaning and must be avoided in the statistical evaluation of data from rating scales and questionnaires (Svensson, 2001).

Jamieson (2004) recommends that when considering ordinal data the median or mode should be employed as the measure of central tendency instead of the mean. Bazeley (2004) discusses the 'pragmatic approach to analyses' in mixed methods where numbers are used to help to answer questions and verbal comments are not ignored.

With the preceding comments acknowledged the decision was made to in this study to threat the data as ordinal data. Data was considered in terms of descriptive statistics and the mode has been quoted as the primary result. The use of descriptive statistics allows the general view of the cohort to be explored in response to an item. Whilst this treatment of the data did introduce some limitations to the statistical testing, it was felt that it was essential to be true to the data type (and as there are only five likert-type responses available on this questionnaire, and the sample size is limited) it was not appropriate to make interval assumptions.

4.12.3 Descriptive Analysis

The first stage in the analysis of the questionnaire was performing descriptive statistics on the individual questionnaire items. Descriptive analysis allows the data to be explored for each item in the questionnaire, producing mean, median and modal values for the items, in addition to standard deviation and skewness. Descriptive statistics also allow the data to be summarised to some extent by producing frequency charts or bar charts for example, which allow an overall interpretation of each item to be gained quickly from a large amount of data.

Descriptive statistics have been used to consider the modal values for each item to determine how the cohort have answered the questions in the questionnaire. A modal value of '1' would show students had strongly agreed, or '2' that they had agreed, '3' would show they were unsure or neither agreed or disagreed, '4' would show students had disagreed with statements, and '5' students would have strongly disagreed.

Descriptive statistical techniques are used to represent and summarise the research variables, rather than allowing generalization to larger populations. The appropriate

descriptive statistics have been calculated and reported; inferential statistics have not been used as in this case statistical generalisation to a larger population is not required (Houser, 2009).

4.12.4 Statistical Tests

Following descriptive analysis, further statistical tests were considered. The data in this study is assumed to be ordinal and as such, purists recommend treatment of the data in specific ways.

Factor Analysis was considered however as the main aim of this study is not to generalise to the population and there was a small ratio of respondents to item numbers, it was not felt that this would be appropriate. Batra and Associates (1995) explains that when there are too many raw variables to work with, factor analysis may be used to reduce the data so that it can be better coped with. The decision is made with data reduction to lose some of the richness of the data; it was felt that this was inappropriate in an exploratory design of this nature. The strength of this design is that it allowed individuals to identify aspects of their teaching and learning context that they held a perception of, or to identify their own practices in response to the context.

By choosing to follow the mixed methods methodology it is felt that reducing data to a level which looses individual items (as identified by students) would not help in understanding the overall scheme of practices and perceptions of students.

Eysenck and Eysenck (1971) agree that scale scores (scores of factors) 'may not always reveal all the important information' and state than 'an analysis of all the individual items' might throw some additional light on the research problems. Furthermore, one should not use factor analysis to reduce the number of variables when the number of variables is greater than the number of observations (Bumb, 1982). In this case there were 91 items/variables on the tool and only 56 observations/completed questionnaires.

4.12.5 Analysing Variance

Statistical tests to determine variance measure 'the differences between sample means' (Gravetter and Wallnau, 20101). Calculating or analysing variance is basically a simple method for measuring how large the differences are for a set of numbers.

With the data in this study there is one main way in which variance between responses will be explored. Variance can be considered by analysing the responses to all items with respect to students' mode of study (full-time, part-time or funded).

To explore variance between groups ANOVA tests are often run. The assumptions of ANOVA are not met when the data for analysis is not from an interval level scale; in this case 'nonparametric tests' have to be performed (Hinton, 2004). In practice, the Kruskal-Wallis test is used for ordinal or continuous variables. The Kruskal-Wallis test is used as an alternative to the unrelated one-way ANOVA (Howitt and Cramer, 2008). The Kruskal-Wallis can be performed on ranked data' (McDonald, 2009). 'The null hypothesis is that all medians are equal H_0: $M_1 = M_2 = M_3$' (Osborn, 2000, p.284) therefore under the null hypothesis it would be expected that the average of the ranks for each group should be about equal. The alternative hypothesis is that not all of the medians are the same.

Although it is appropriate in this research, it is acknowledged that there can be 'a loss of power when choosing the non-parametric version and often a loss of the flexibility offered by the parametric version' of a test (Howitt and Cramer, 2008).

To further explore variance the descriptive statistics will be explored for any items which show significant variance. This is so that analysis supports the dominant qualitative nature of the methodology, rather than applying post-hoc tests and focusing further on quantitative detail.

4.12.6 Analysing Correlations

Correlation tests were carried out on the data to look for any evidence of relationships between variables. A correlation coefficient is a statistic that indicates the strength and direction of the relationship between the variables for one group of participants; it does not provide evidence of causation (Kassin et al., 2010).

When correlation analysis is required for ordinal data, the Spearman correlation coefficient can be used. The Spearman rank-order correlation test is the nonparametric equivalent of the Pearson correlation' (Hinton, 2004). A variable can have positive, negative or no correlation with another variable (Siegel, 2011).

De Vaus (2013) provides guidance on interpreting the relationship coefficients. A result of '0' indicates that there is no linear association between the variables. A result of '1' indicates a positive linear relationship and a result of '-1' indicates a negative linear relationship. For those results ranging between '0' and '1', both positive and negative, there are general rules of thumb which can be applied to interpret the strength of the relationship coefficient (however the strength of a relationship is open to interpretation). To determine if a relationship is very strong a coefficient higher than '0.7' would be expected. A coefficient of less that '0.3' would suggest a low, or small, relationship between variables. The range of '0.30-0.49' indicates a moderate to substantial linear

relationship, and the range ‘0.5-0.69’ suggests a substantial to very strong linear relationship.

Correlation coefficients are usually based on samples of data. As a consequence, it is necessary to also test the statistical significance of correlation coefficients. The results section includes tables produced in SPSS to show the correlations and also indicate at which level the results are statistically significant. The tables also show the sample size that the calculations were calculated for.

4.13 Detailed Example: the Qualitative Data Informed by the Quantitative Design

This section details the process of using qualitative data to inform the quantitative data collection instrument. In this section an emergent theme has been selected to demonstrate how data from the transcripts were transformed into items on the questionnaire.

The interview transcripts made clear that a range of issues involved with peer working were discussed by students, such as how often they choose to engage, who they choose to engage with and why they choose to engage. These issues are therefore required to be explored in the quantitative stage to determine if the cohort, as a whole, exhibit similar peer working behaviours.

Below are some transcription excerpts relating to peer working so that the process of developing the quantitative tool based on the qualitative data can be demonstrated:

Frequency of peer working:

> ‘*Come in to study when we're not scheduled for lectures and we're in Uni every day, studying; but I look forward to that.’*

Change in need to engage in peer working:

> *‘I think it's, not so much drifting off, it's just that we're not finding the need to as much. I still ring up 'Oh have you done this? How did you get that?’*
>
> *‘I still work with them but there is definitely a different group dynamic… there is definitely an element of elitism floating around… they’re the high-achievers and they’re doing really well, and they certainly keep within their little close-knit group.’*

Developing understanding:

> *‘But that was mainly down to working with the team, like, with my mates and everyone, we all put something into it. So we all got to work it out together.’*
>
> *‘We were on the same kind of level and we were sitting quite close to each other in class and it was good working together because there were a few things I didn't know ... and he would help us (sic) out, and vice versa...’*

Sharing of information:

> *'… We worked for a few weeks on it and got 100% on that one. But quite a lot of the [people on our] course came into our study area on the last day and quite a lot of people got high scores and we'd worked for two weeks and … After about 20 minutes I actually told the people to go away. I said, 'We've worked hard on this and I don't want you taking our ideas' but we'd already basically given the ideas to a few people.'*

The data in relation to 'Peer Working' was used to inform a selection of questions in the questionnaire based on the same theme. To determine what aspects of peer working should be explored by the questionnaire meant careful consideration of the coded items relating to peer working. This allowed the key issues that students were discussing to be highlighted.

It was evident that there were six ways in which students were discussing peer working. Students were talking about:

- How readily they would share information with others and how they would decide who to share information with.
- How often and when students were choosing to work with peers.
- How students were using peers rather than staff to support learning.
- How students saw peer working benefiting their own learning.
- Changes in the way students had experienced peer learning over the academic year.
- How students decide which of their peers to work with

Questions were therefore needed to explore all of these issues as all were considered to be relevant to the aims of the research. The qualitative data based on peer working (and the six aspects within it) were considered and used to produce the six questionnaire items below:

Q 36 Throughout this year I have chosen to work with others on several occasions.
Q 37 I am careful how much knowledge I share with other students.
Q 39 Last year I needed to ask my friends more about how to tackle work.
Q 41 If I am finding something difficult in classes my first response is to ask other students.
Q 45 Talking with other students helped develop my understanding.
Q 52 I often discuss assignments with others who are at a similar academic level as me.

Tables 7 to 11 provide further excerpts of qualitative data. The tables also offer some of the initial interpretations of the data and present the questionnaire item which resulted to enable that particular aspect to be explored.

4.14 Conclusion/Summary of the Research Process

This chapter outlines the techniques which were applied to ensure the quality of the research was maintained. It also outlines, in detail, the phases of the research to ensure transparency and to aid understanding of the research process.

The following chapter presents the results in full, showing both data types and also providing integration of the qualitative and quantitative data so that the true strength of the mixed methods approach can be utilised.

5. Results

5.1 Explanation Regarding Treatment and Presentation of Data

As discussed in the previous chapter, the research process involved analysis of the qualitative data before analysis of the quantitative data and before integration of both data types. Figure 11 outlines the structure of this chapter.

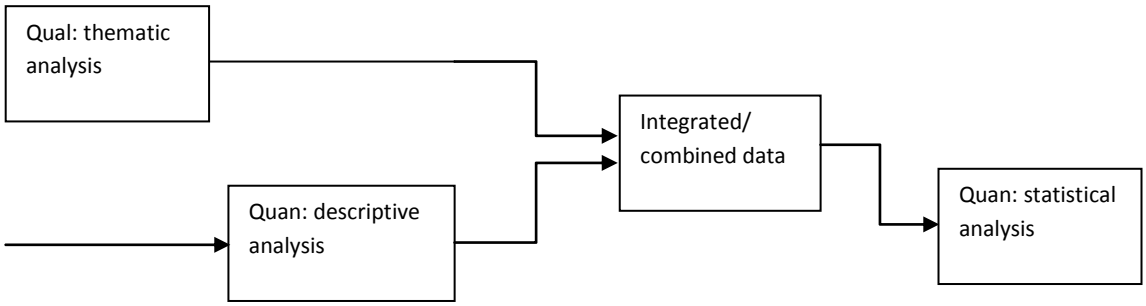

Figure 11: Chapter 5 structure.

A summary of the qualitative findings are presented first, followed by the results of the descriptive analysis (with the modal score presented with priority). Following the presentation of the quantitative data, section 5.5 shows the initial process of considering both the qualitative and quantitative data together.

Following the presentation of the combined results, a statistical analysis of variance, and a correlation analysis, are presented.

The process of data integration is further developed in Chapter 6 to allow a greater depth of learning from the data to take place. Chapter 6 also includes further discussion of the findings with specific relation to the research question.

5.2 Qualitative Results Summary

Coding of the transcripts took place following the phase one interviews and then again following the phase two interviews. Codes from phase one were reconsidered during the phase two analysis; some of the codes used during the second phase analysis were the same as those from the first phase, others were modified versions of the phase one codes or new codes entirely. The codes used are shown in Table 1.

The a-priori and emergent coding used can be considered to represent several themes (or categories) within the data. Whilst the codes themselves are useful to allow the data to be explored, they did cause the data to appear segmented and made coherent interpretation of the whole context difficult. Therefore, the decision was taken during analysis to consider the data in terms of themes/categories (which support the

interpretation and holistic understanding of the findings in this study). These themes were later used in the organisation of the quantitative tool.

The themes suggest the subjects discussed by students while the codes included within these themes provide a higher, and more prescriptive, level of detail. Table 1 provides detail of the coding, and the general themes of the data.

Categories	Phase One Coding	Categories	Phase Two Coding
Approach	- Approach - Deep Learning - Strategic Learning - Surface Learning - Trying To Learn -	Approach	- Approaches - Approaches~- Surface, Deep, Strategic - Trying To Learn - Achievement
Subjects & Classes	- Discipline - Difficult - Important - Less Important - Easier - Pace	Subjects & Classes	- Difficult - Discipline Content - Discipline Preconceptions - Effect Of Lecture - Easier - Perception Of Importance - Method Needed For A Discipline - Questioning – Etiquette In Lectures - Perceived Difficulty Of A Problem - Concepts With Emergent Qualities, - Too Much Content - Continuity - Relation Of Theory To Practice
Ways Of Learning	- Peer Work - Use Of Time To Study - Use Of Resources - Clarification - Doing The Right Thing - Reading - Strategy - Examples And Questions To Work Through - Learning	Ways Of Learning	- Comparing To Other Students - Use Of Time To Study - Strategy - Persons Behaviour – e.g. Independent Work - Routine - Participation In - Need To Reflect - Change In Peer Dynamics - Active Engagement With Learning Task - Access To Materials On-Line - Helped - Peer Work – Approach - Example To Work Through - Avoiding - Checking Work
Assessments	- Assessment - Routine - Feedback - Effect Of Assessment	Assessments	- Assessment - Feedback - The Clarity Of Goals And Standards - Variety Of Assessments Tasks - Demands Of A Course's Assessment Regime - Identifying What Is Being Learned - Difficult To Judge Progress - The Standards Expected By A Teacher - Can't Remember

University Staff & Structure	- Lecturer Reliability - Lecturer - Teaching Strategy - Teaching Structure - Handouts - Communication - Expectation - Caused Problems - Timetable - Structure - Blackboard	University Staff & Structure	- Teaching Methods~Strategy - Teaching Quality - Expectation About What Staff Should Do - Guidance They Are Given In Support Of Learning - Quality Of The Relationships Between Staff And Students - Patient Explanation And General Supportiveness - Teaching Structure - Lecturer Reliability - Approachability - Respect - Manners - Suggestions - Caused Problems - Organisation - Surrounding E.G Library - Teaching Environment - Workload - Course Structure - Course Design - Resources - Coherence
Personal	- Attendance - Enjoy - Distractions - Unhappy - Motivation - Identity - Perception Of Self - Previous Experience - Interesting - Relevance	Personal	- Confidence - Attitudes, - Attendance - Motivation - Identity As An Engineer - Previous Experiences - Relevance - Liking~Disliking - Current Understanding - Prior Academic Achievement - Socio-Culture - Quality Of Relationship With Peers - Distractions - Professional Identity Or Skills - Satisfaction - Identity / Development Of Self - Personal Responsibility

Table 1: Example of themes and coding from interview data

5.3 Discussion of the Interview Findings

Whilst the codes on their own give a flavour of what was discussed/explored in the data, the description following is intended to give an idea of how the interviews progressed. Further detail from interviews will be given in section 5.5.

The data has shown that some of the factors which influence the practice and perceptions of students occurred even before their involvement in the university teaching and learning context. It is evident that students have ideas and expectations about their experience of HE.

Students have their own motivations and orientations towards studying and personal conceptions of what they hope to gain from the experience. These students appear to have expectations about how teaching should be done and opinions about how their peers should behave. Students have ideas about what the different years of study

should be teaching them, and also ideas about how they should be behaving throughout different stages of the course.

Some of the views and opinions expressed by students were based on previous experiences/expectations which then developed as their time at university progressed. Students discussed difficulties and areas of confidence with respect to subjects studied. Modules were discussed in terms of what students felt to be 'core', important or most relevant to emerging or potential future careers.

The students reflected on the demands of both the assessment regime and the workload. Students identified difficulties they faced in judging their own progress during the academic year. The issue of *quality of learning* was investigated; this led onto exploring whether effort and learning were reflected in marks. Students' preparation for assessment tasks was explored, as were their general approaches to learning at the different times throughout the year and how these were affected by assessment demands.

The expectation about the amount of learning that could be gained from classes and interactions with staff was explored. This fed into questioning about what students did in their time outside of class and which subjects they studied most for. This also led to an exploration of students' peer working and discussion of when they would ask for support from staff and peers. Issues about the constraints of the timetable were explored as were the availability of additional resources and the physical learning environment.

With respect to teaching specifically, there was focus in the interviews on learning outcomes; the clarity of tasks set and outcomes achieved. Aspects of teaching were explored with respect to what students felt helped their learning. The professionalism and organisation of staff was also explored in relation to how this affected learning and the effort students apply in modules. Students expressed their need for having example problems to work through and in seeing the methods of solution discussed in class to help support their learning.

5.4 Descriptive Analysis of Quantitative Data

Subsequent to the qualitative data analysis, and the formation of the questionnaire and data collection, descriptive analysis of the questionnaire was conducted. The descriptive analysis was supported by the use of the software PASW with results from the questionnaire presented below. The modal value gives an idea of how the cohort overall rated each individual questionnaire item: a score of 1 indicates that students 'agree' with a response, 2 indicates they 'agree somewhat', 3 represents that students

were either unsure or neither agreed of disagreed, 4 indicates students 'disagree somewhat' and 5 suggests students 'disagree' with the statement.

The following table (Table 2) lists all of the questionnaire items with a modal score of 1, therefore indicating that the cohort were in agreement with the item. Out of 90 questions, 29 items were agreed with by the cohort (two of these had multiple modes of which the highest scoring is presented* i.e.1=high).

	Item	N	Mean	Median	Mode	σ
Q1	I hope the things I learn will help me to develop as a person and broaden my horizons	56	1.36	1	1	0.554
Q3	I hope the whole experience here will make me more independent and self-confident	56	1.54	1	1	0.852
Q4	I want to learn things which might let me help people, and/or make a difference in the world	56	1.73	1	1	0.884
Q5	I want to study the subject in depth by being involved in a range of interesting modules	56	1.75	2	1	0.769
Q6	I mainly need the qualification to enable me to get the job I want	56	1.66	1	1	0.920
Q18	I have done less independent study for one subject than others this year	56	1.93	2	1	0.931
Q25	Space and comfort in lectures affects how much attention I pay to classes	56	1.73	1.5	1	0.944
Q30	Without worked examples in a lesson it is difficult to see what I've learned	56	1.29	1	1	0.494
Q31	Without handouts it is difficult to understand what I'm learning	56	1.46	1	1	0.762
Q33	The lectures, handouts and other materials we were given helped me to understand the unit	56	1.79	2	1	0.868
Q34	I like to be taught subjects in small steps building up to a bigger picture	56	1.55	1	1	0.658
Q41	If I am finding something difficult in classes my first response is to ask other students	56	2.11	2	1	1.275
Q42	I need time working on my own to really learn something	56	1.93	2	1	1.059
Q44	I have done more independent study for Mechanics and Energy than other subjects	56	3.14	2	1*	4.167
Q45	Talking with other students helped develop my understanding	56	1.66	1	1	0.900
Q46	During the year my independent study mostly focussed on what was assessed	56	1.66	2	1	0.745
Q48	At least once this year I have left work until near the deadline and had to ask other students for help	55	2.89	3	1	1.536
Q51	For tests I like to prepare on my own	55	2.2	2	1*	1.129
Q59	There is at least one subject that I'm aiming to just pass rather than really understand	56	2.48	2	1	1.452
Q62	I put less effort into subjects when I don't think the lecturer teaches well	55	2.13	2	1	1.292
Q63	Unprofessional staff (e.g. poor timekeeping) affect how seriously I work towards a module	54	1.85	1	1	1.172
Q70	It hinders my learning when staff refer me to a book instead of giving me the answer	55	2.15	2	1	1.177
Q71	The quality of some teaching hasn't been what I expected	55	1.75	1	1	0.947

Q74	Second year requires you to be more responsible for your own success than first year	53	1.62	1	1	0.925
Q77	I have enjoyed this year more than first year	53	2.43	2	1	1.337
Q80	I am more motivated than in first year because this year counts towards my final mark	54	1.98	2	1	1.090
Q84	I am motivated by a fear of failing	54	1.74	1	1	1.085
Q86	The subject material is much more difficult this year	53	1.7	2	1	0.749
Q87	I often write extra notes or add my own notes to handouts	54	1.93	2	1	1.007

Table 2: Items with a modal value of 1.

Table 3 below, shows that 44 out of the 90 items were agreed with somewhat by the cohort (mode of 2). There was one item which had a multiple mode and again the highest mode is represented.

	Item	N	Mean	Median	Mode	σ
Q2	I'm focused on the opportunities here for an active social life and/or sport	56	2.73	3	2	1.228
Q8	I have generally put a lot of effort into my studying	56	2.09	2	2	0.959
Q10	In making sense of new ideas, I have often related them to practical or real life contexts	56	1.96	2	2	0.762
Q11	On the whole, I've been quite systematic and organised in my studying	56	2.45	2	2	1.060
Q12	It has been important for me to see the reasons behind things	56	1.77	2	2	0.687
Q13	I've tended to take what we've been taught at face value without questioning it much	56	2.7	3	2	0.952
Q14	Concentration has not usually been a problem for me, unless I've been really tired	55	2.07	2	2	0.979
Q16	If I've not understood things well enough when studying, I've tried a different approach	56	2.3	2	2	1.008
Q17	In some subjects I am unsure what I've actually learned	56	2.21	2	2	1.091
Q20	Mechanics and Energy were more difficult than other classes this year	56	1.93	2	2	1.006
Q21	My strengths in subjects this year are the same as last year	56	2.45	2	2	1.190
Q22	The business and manufacturing module is not as important to engineers as other modules	56	2.96	3	2	1.427
Q23	It was clear to me what I was supposed to learn in most subjects	56	2.29	2	2	0.909
Q24	You have to really understand the subjects to get good marks	56	1.7	2	2	0.630
Q27	I would need to have a significant problem that was affecting my learning before I would ask a question in a lecture	56	2.46	2	2	1.159
Q29	I put more effort in to subjects that seem to be organised well	55	1.71	2	2	0.762
Q32	What we were taught seemed to match what we were supposed to learn	56	2.16	2	2	0.757
Q35	I do less independent study for modules that aren't important to me	56	2.39	2	2	1.039
Q36	Throughout this year I have chosen to work with others on several occasions	56	2	2	2	1.079
Q38	I've put more hours into my weekly studying compared to last year	56	2.34	2	2	1.164

Q47	I often use formulas without trying to understand the theory	56	2.75	3	2	1.179
Q49	I used the assignment schedule to help me plan my work	56	2.63	2	2	1.229
Q50	My marks so far are reflecting my effort and my learning	56	1.91	2	2	0.859
Q52	I often discuss assignments with others who are at a similar academic level as me	56	2	2	2	1.027
Q53	I plan to concentrate most on Mechanics and Energy for the exams	56	2.14	2	2	1.017
Q54	The handouts have been enough to help me do most assessed work.	56	2.66	3	2	1.133
Q55	Assignments have helped me learn as much or more than class tests	56	2.2	2	2	1.102
Q56	I am leaving tutorial problems until the end of the year so I can use them for revision	56	2.36	2	2	1.212
Q57	It was clear what was expected in the assessed work for the course	56	2.46	2	2	0.934
Q58	The feedback given on assessed work helped me to improve my learning and studying	56	2.43	2	2*	1.059
Q61	I am going to be tactical in choosing what to prepare for some exams	56	2.14	2	2	1.182
Q64	Interactions with most staff have been beneficial to my learning	55	2.18	2	2	1.002
Q67	The workload has been too heavy at times for me to really learn	53	2.32	2	2	1.221
Q68	The timetable has made it easy for me to do my own studying around lectures	55	2.55	2	2	1.199
Q69	Access to rooms and resources has helped me learn	55	2.24	2	2	1.071
Q72	If teaching isn't ideal I ensure I understand the material by doing independent study	55	2.25	2	2	0.966
Q75	I have made a conscious decision about the type of student I am	54	2	2	2	0.932
Q76	I am more confident in my own ability this year	54	1.96	2	2	0.776
Q79	When I feel like I've learned a lot it doesn't always show in my marks	54	2.28	2	2	0.940
Q81	Personal factors have had more negative affects on my learning that anything at University.	54	2.26	2	2	1.013
Q82	If there are small things I am unsure of I wait until I revise for exams to try and understand them	54	2.48	2	2	1.077
Q85	I have found it difficult to maintain a constant motivation & effort through the year	54	2.07	2	2	0.988
Q88	I found most of what I learned in this course really interesting.	54	2.26	2	2	0.828
Q89	The amount of work I was required to do was what I expected	54	2.35	2	2	0.994
Q90	I am rarely satisfied that my work is as good as it could be.	54	2.3	2	2	1.002

Table 3: Items with a modal value of 2.

Considering tables 2 and 3 together, it can be seen that 73 out of 90 of the items on the questionnaire were in fact agreed with or agreed with somewhat by the entire cohort involved. This large agreement demonstrates that the overall cohort view was very similar to the view expressed by the sample interviewed.

	Item	N	Mean	Median	Mode	σ
Q9	Much of what I've learned seems no more than lots of unrelated bits and pieces in my mind	56	3.09	3	3	0.996
Q26	Lectures and tutorials are taught and organised in line with my expectations	56	2.86	3	3	1.086
Q37	I am careful how much knowledge I share with other students	56	3.5	3	3*	1.221
Q39	Last year I needed to ask my friends more about how to tackle work	56	3.14	3	3	1.151
Q40	Sometimes when a task is easier I put less effort in and don't do as well as I could	56	2.73	3	3	1.104
Q43	I have done more independent study than I planned to do this year	56	2.86	3	3	1.285
Q83	Mechanics and Energy were the more important than other subjects this year	54	2.37	2	3	1.186
Q66	I find it difficult to find time to ask staff all the questions I have.	55	2.47	2	3	1.168
Q60	Lack of class tests has made me unsure of my progress this year	56	2.68	3	3	1.295

Table 4: Items with a modal value of 3.

	Item	N	Mean	Median	Mode	σ
Q15	I've just been going through the motions of studying without seeing where I'm going	56	3.32	3.5	4	0.993
Q65	I need less direction from staff this year than last year	55	3.26	3	4	1.102
Q73	Most staff do enough examples in their classes so I don't need seminar sessions	55	3.24	3	4	1.154
Q78	I enjoy high workloads and difficult tasks as a chance to prove myself	54	2.87	3	4	1.304

Table 5: Items with a modal value of 4.

	Item	N	Mean	Median	Mode	σ
Q7	When I look back, I sometimes wonder why I ever decided to come here	56	3.82	4	5	1.223
Q19	I choose carefully which timetabled sessions to attend	56	3.29	3	5	1.522
Q28	I do not think it is appropriate to take up time in lectures asking questions	55	3.31	3	5	1.332

Table 6: Items with a modal value of 5.

The previous three tables (4, 5 and 6) show the items with a modal value of 3 that students neither agreed or disagreed with (or were unsure about). The items students disagreed with somewhat are shown with a mode of 4 and the items with a mode of 5 are those that students disagreed with. There were nine items that students were unsure about and only seven items that the whole cohort disagreed or disagreed with somewhat.

5.5 Initial Data Integration

The remainder of this chapter shows the first level of data integration, displaying the questionnaire items alongside an example of the qualitative data which directly informed their design. These are accompanied by some description of the context, in addition to summaries of the quantitative data.

The seven broad headings which were used to give structure to the questionnaire are used (as headings of sections 5.5.1 – 5.5.8) to allow the data to be presented in a clear format. It can be seen however from the qualitative examples provided that there is a large amount of overlap between sections.

The integration of both qualitative and quantitative data here allows the strength of mixed method research to be observed as it provides a more thorough understanding of the student views. Tables 7 to 11 show the integration of both types of data and demonstrate questionnaire items 17 - 90. Questionnaire items 1 – 16 are not discussed in the tables as these items were developed from the literature rather than the qualitative data.

5.5.1 Expectations of the Higher Education

The first two sections in the questionnaire consisted of questions taken from, and adapted from, the SETLQ (ETL-Project, 2005). The first section of the questionnaire (items 1-7, appendix K) allowed the sample to be classified based on their expectations of Higher Education. The data shows they are intrinsically motivated, with strong career orientations and are focussed to some extent on developing personal skills such as self-confidence. Very few students identify a lack of purpose with regard to their studies. Some students expressed a definite career orientated view and were motivated towards achieving their personal goals *'...It's all for me, it's not for anybody else and I'll always put 110% in no matter in what I do…'.* There was a perception that students were on their course *'...to try and get a career'* and that having a first class honours degree was desirable; *'it will make me more competitive I think...'*

5.5.2 Approaches to Learning and Studying

The interviews themselves explored the actual learning practices of students; looking at their approaches to learning but also looking at practices towards study in general, exploring questions such as how, where, when, why, who with?

The student practices which were referred to during the interviews were explored throughout the questionnaire. The SETLQ was also used to specifically obtain a series of items which could explore approaches to learning. Exploring *approaches to learning*

initially through items 8-16 (appendix K) allowed the cohort to be classified (to support interpretation of the other questionnaire responses). An organised effort is tested by questions 8, 11 and 14; a surface approach by questions 9, 13 and 15; and a deep approach by questions 10, 12, 16.

Questions 8, 10-14 and 16 have a mode of 2 showing students agree somewhat with the items designed to explore deep learning and those designed to explore an organised effort. With respect to the items exploring surface approaches, there is a greater mix of responses; item 13 had a mode of 2, item 9 had a mode of 3 and item 15 had a mode of 4. This may show that although students are organised in their studies, there are still times when they have taken surface approaches. There is stronger evidence that as a group, these students have taken deep approaches (shown in their responses to items 10, 12 and 16) throughout their studies than surface approaches.

These deeper approaches were evidenced with quotes such as '*I believe cramming means you don't know what you're doing. It's nicer to understand what you're doing then it makes it easy' and:*

> '*… I always want to see how it goes… how the formula has been arrived at, also it is more useful to know… formulas, you can forget, but how it comes you can remember… I think it's a better way, it's more interesting as well… you can add everything together to one understanding.'*

Students who did take surface approaches held views such as *'To be honest…with every lesson, I just want to get as much as I can done and just get it over and done with.'*

5.5.3 Subjects and Classes

This section of the questionnaire explored the perceptions that students held regarding the clarity of their learning in classes, their personal ability and their overall opinions of subjects.

The items explored students' questioning behaviour in classes and the existence of strategies which students made use of (for example, to determine their practice in relation to effort and attendance). Students were asked about whether organisation of classes met their expectations and whether leaning in subjects was required to enable them to achieve good marks.

When asked how they felt about the fundamental engineering topics of maths, energy and mechanics, students had views on what they considered to be their strengths and weaknesses. Students described their perceptions of the subject in relation to which subjects in the undergraduate programme were important (considering importance and

relevance in terms of what subjects they felt were core to the programme, relevant for future careers and/or core to the nature of the engineering discipline). They also discussed perceptions of how difficult or easy they felt the course was and also the need to refer to, or availability of, resources.

Table 7 (Presentation of 'subjects & classes' data) shows the questionnaire item, provides a description and some context and shows examples of the qualitative data obtained on the same theme.

5.5.4 Ways of Learning

This section of the questionnaire focused on what students perceived their own learning preferences to be. It also reflected the qualitative comments obtained relating to students learning practices such as their use of independent study or peer working. Table 8 (Presentation of 'ways of learning' data) provides the detail.

5.5.5 Assessments

The assessment aspect of the questionnaire came from several elements of the qualitative data. Within the assessment theme assessment preparation, opinion about assessment type and use of feedback were amongst the topics explored. The detail of the qualitative and quantitative data is in Table 9 (Presentation of 'assessments' data).

5.5.6 University Structure and Staff

This section of the questionnaire asked students to reflect on their perceptions of specific aspects of the structure of the programme such as timetable, workload, rooms and resources. Students were also asked to consider how interactions with staff have affected their learning and their learning practices

Within the interviews students gave examples of helpful staff and the teaching that they found helped them learn. There were a range of factors in common with these examples, such as teaching in small steps i.e. breaking down more complex topics into manageable procedures, giving full explanations of why topics were being covered, setting the appropriate pace and level, using examples and the availability of supporting material. Despite giving positive examples of teaching, students were also able to give examples of negative teaching experiences they have had: Table 10 (Presentation of 'University staff & structure' data) shows the detail related to this theme.

5.5.7 Personal Factors

The interviews demonstrated the range of personal factors which go alongside and influence students' studies. This section of the questionnaire was designed to reflect

this and to acknowledge that personal factors, prior experiences and perceptions also play a part in guiding students' approaches and practices in learning. The Presentation of the 'personal' factors' data is in Table 11.

Table 7: Presentation of 'subjects & classes' data.

Example of qualitative data	Description/context	Questionnaire item
'*For [subject] I really don't know what we learned this year. ... I don't know, what to read... So actually nobody knows what will come in the exams.'*	In the interviews students described some instances where they felt unsure about what they had learned or were supposed to be learning. In the questionnaire (which was administered after 25 weeks of study), almost three-quarters of students agreed that they were 'unsure of their learning in some subjects' (mode of 2).	17. In some subjects I am unsure what I've actually learned.
'I haven't put anywhere near as much time into Business and Manufacture.'	The quantitative data supports the qualitative with almost three-quarters agreeing that they spend less time on one subject than others.	18. I have done less independent study for one subject than others this year.
'Yes I wouldn't miss a day if I could help it' '*On a Tuesday ... there's nobody in on a morning, or very few, ... and then you get to midday and everyone's in, and then it gets to about 4 o'clock and then everybody starts drifting off.'* '*...Basically turn up for everything. I'm not going to miss anything. I haven't yet so I won't.'* '*... last week I had so much work to do on that assignment I had to skip the lesson, I had to go the library and finish it off before I handed it in.'*	In the qualitative component students described that they observed some peers who frequently did not attend or who regularly missed classes or full days of timetables sessions. Students were asked about their study plans for the year and several of the students felt attendance was a crucial factor. Students in the interviews gave details of their attendance and most students acknowledged that they did try to attend all sessions. The item provided a mixed response in the quantitative data with about 45% of students saying they don't choose which sessions they attend, but almost 40% saying they do select carefully which sessions they attend (mode of 5).	19. I choose carefully which timetabled sessions to attend.
'...I didn't have a clue to how to even start [Mechanics assignment]; we had to ring each other…' *'Probably still struggling a bit with some of [the Energy] stuff, and [the Mechanics] stuff. That's just the sheer factor of how complicated some of the stuff that we do is.'*	Around three-quarters of students (mode of 2), agree with the qualitative suggestions that the fundamental subjects of Mechanics and Energy are the most difficult	20. Mechanics and Energy were more difficult than other classes this year.

Table 7: Presentation of 'subjects & classes' data.

'[Design] was a strong point ... and it still is.' *'I'm certainly, although I'm still not great at it [Maths], I'm certainly understanding more.'*	Some students gave examples in the interviews of becoming more confident in their own abilities whilst others felt their weaknesses had remained from their first year. Three-quarters of students agreed with the statement in the questionnaire which asked whether their strengths were the same as last year (mode of 2).	21. My strengths in subjects this year are the same as last year.
'The Business part, I don't see me using it much in the future, that's the only thing.'	It is suggested from some of the interview comments that students are inferring importance from perceptions of the course design or perception of their future careers. The data gathered in relation to the item about importance (22) was one of the few to show wide spread views amongst the cohort. Approximately 43% agreed that the module is less important than other subjects, 40% disagreed, and approximately 17% were unsure. Overall, results showed a mode of 2.	22. The business and manufacturing module is not as important to engineers as other modules.
'he said, "just do the final report, and then just see what stuff you've sort of done, like, put your research in that you've done, do the final report with a couple of drawings about what you'd done and then you just try and put it all together". So they let us through with that one.' *'I don't know how the assessment worked. I think you winged it really'* *'Yes, when the lecturer seems confident and everything is planned out, it seems so much easier, you don't have to stress about 'Oh should I write this down? Do I need to know this or not?''*	The qualitative data showed some occasions where students were unsure of their learning outcomes. This item was therefore written to investigate whether this was the case in all subjects or whether the lack of clarity was only true for limited situations. Examples show the contrasting views regarding clarity. The mode for this item is 2.	23. It was clear to me what I was supposed to learn in most subjects.
'...an assignment is a list of something you need to do. I could not turn up to that lecture all year, get an assignment, go to the library and probably get 65% on that. In a class test, you have to go to those lectures, you have to do tutorials...'	This item was written following reflection on the quotation shown here which suggested that students could get high marks by completing a list of tasks. Pleasingly, almost all students (mode of 2) felt strongly that they needed to understand to get good marks; this potentially may suggest the need for students to try to understand material by adopting deeper approaches.	24. You have to really understand the subjects to get good marks.

Table 7: Presentation of 'subjects & classes' data.

'That has been sorted ... at the start of the year, it was a joke... some rooms didn't have enough seats.' *'not much effort went into planning.'*	Space and comfort in lectures was explored in some interviews with some negative initial comments related to the scheduling of rooms at the start of semesters. The item was included to determine whether students felt this had any impact on them. The quantitative data showed that over 80% of students felt that space and comfort directly affected how much attention they paid in classes (mode of 1).	25. Space and comfort in lectures affects how much attention I pay to classes.
'He came in and was well organised and he told us what we were learning and he had the appropriate handouts and he went through everything and by the end of the lesson you knew what you were learning and it was quite difficult, you had to concentrate but at least you knew what you'd learnt that lesson and stuff like that.' *'... the lecturer came across really well and he seemed really organised and excellent notes and everything, dead clear in what he's saying...'*	Students discussed the organisation and teaching during, classes with respect to personal expectations about how the activities should be done. The item allowed it to be seen that students neither agreed or disagreed (or were unsure) that classes met their expectations. Examples given here reflect students expectations. The modal value for this item was 3.	26. Lectures and tutorials are taught and organised in line with my expectations.
'I'm not really one for sticking my hand up in class. If I don't get something then I'll just carry on listening and then try and figure out myself and if I can't then I'll come back in and ask. But to do it in class is a bit rude I think.' *'… I'll usually ask a lecturer the purpose of what they've put on and will just ask a friend for a process…'*	Students appear to have preconceived ideas about when they should ask questions. Students acknowledged that they would ask questions in class however they would choose when to ask the lecturer or when to just ask a peer. In the questionnaire almost 60% of students said they would need to have a significant problem that was affecting their learning before they would ask a question in a lecture (mode of 2).	27. I would need to have a significant problem that was affecting my learning before I would ask a question in a lecture.
'We're not all on the same level and it just seems silly if 50 people ask one question. I mean sometimes it's always the people who are struggling that ask the more questions. I mean, not always, but mostly and I just think that it hinders the rest of us.'	The use of the quantitative data showed a contrast to the example given in the initial qualitative data. A mode of 5 was evident from the quantitative data; this showed students disagreement with the statement.	28. I do not think it is appropriate to take up time in lectures asking questions

Table 7: Presentation of 'subjects & classes' data.

'… it kind of affects us… it annoys us a little bit and gets us frustrated, but I want to do really well in every subject so I know if I'm not getting the help I need I just need to concentrate on that subject more and I don't think it will affect how much effort I put in.' *'We'll have the lecture, he'll want a break... and then we come back and, I don't know... just seems to be the standard of the lecture where [as] some people come in and they get down to business and they look presentable, their handouts are presentable, you know what you're learning in that lesson...'* *'... you leave with maybe two lines written down and you're thinking 'What have I just done?' (Laughter). 'What has he been going on about?' … Like, they [other students] might do the first hour and just go, '...no way… I'll come back for the next lesson.'*	The literature states that how a subject is delivered can be more important than the subject content itself. In the interviews students described occasions where they had not responded well when staff seemed disorganised. There were however examples of students responding with greater independent effort after experiencing delivery of a subject that was not ideal. The quantitative data allowed this to be explored to see how the cohort felt they approached a subject which seemed disorganised. Almost 95% of students acknowledged that they put more effort in to subjects that seem to be organised well (mode of 2).	29. I put more effort in to subjects that seem to be organised well.
'*There are a lot of worked examples in there so it's okay getting through the stuff.'* *'without, you know, if you're not going to get examples then I don't think you can do anything, reading just the notes on theory doesn't help'*	Students placed a lot of value on having worked examples so that they can see how solutions have been arrived at. 98% found it difficult to learn without worked examples in a lesson (mode of 1).	30. Without worked examples in a lesson it is difficult to see what I've learned.
'seemed a bit aimless at first.... we didn't seem to be doing any work or have anything written down, no handouts or anything like that' *'[The handouts are] very helpful, because he goes through everything, and he has the same bits of paper up on the board and he reads through it with you and all the ones he wants you to fill in on the sheet... they are all the important bits and all the equations and stuff like that…'* *'...because it's just pages of text with some words missing... in the end, you're not reading through the text or not listening to the lecturer' what you're doing is looking on the board for the one that's highlighted and just putting it into that box so...I may have gone back to look over them and I understand it all, but during the lecture it's not going in.'*	The presence and quality of handouts seem to be related to the overall experience of the teaching and the evaluation of the teacher. 91% felt it was difficult to understand what they were learning without handouts being given in classes (modal score of 1). There was contrast in the qualitative data however regarding the suitability of handouts that were designed around the method 'fill-in-the-blanks.'	31. Without handouts it is difficult to understand what I'm learning.

'It was fun and I liked it but I didn't see the point in it.'	Across all subjects almost three-quarters of students felt that what they were taught seemed to match what they were supposed to learn (mode of 2). There were however occasions where the learning aims seemed to be unclear.	32. What we were taught seemed to match what we were supposed to learn.
'I mean he brings examples and from tutorials, brings examples, and talks about it, so you can come to tutorials and you know where you are, you are already prepared.' *'...Most peoples' {notes] are pretty good.'* *'Yes, and just the way that he teaches as well, his notes are clearer and easier to understand'.*	85% of students felt the lectures themselves, in addition to the handouts and other materials they were given, helped them to achieve an understanding of the subject material (mode of 1).	33. The lectures, handouts and other materials we were given helped me to understand the unit.

Table 7: Presentation of 'subjects & classes' data.

Table 8: Presentation of 'ways of learning' data.

Example of qualitative data	Description/context	Questionnaire Item
'… when he lectures, he doesn't expect you to know everything.' *'he really starts at the bottom and then builds up to kind of the way you should be doing it'* *'...the reason he can explain something very basically is because in his mind he can break it down...so he'll take his time and understand each step that a person who's just doing it might go through…'*	The quantitative data showed that almost 90% of the cohort agreed that they consider this to be the type of teaching they prefer (mode of 1). The quotes indicate why students found this to be helpful.	34. I like to be taught subjects in small steps building up to a bigger picture.
'The Business part, I don't see me using it much in the future, that's the only thing.' *'I find Thermodynamics the most interesting and that seems the most relevant. Maths, everybody I've spoken to says 'You don't use Maths; it's all computers' … That's jumping through the hoops I suppose.'* *'The subjects I'm going to pay most attention to again are the core subjects simply because the other ones, I feel that I'm weakest in. All of them… I don't know. I mean, I know the ones that I want to do well, the core ones, just mainly because if I can get through them then I know I'll certainly be able to get through the others…'*	The idea of importance was introduced by students in the qualitative stage. About 60% of students felt that they did do less study for subjects that were less important to them (mode of 2). A considerable number however (almost 30%) were unsure/neither agreed or disagreed. The concept of importance appeared to be influenced by students' perceptions of the programme, the discipline and their future careers.	35. I do less independent study for modules that aren't important to me.
'*we're not scheduled for lectures and we're in Uni every day, studying; but I look forward to that.'* *'I do better by myself I think, unless I can't do it and then I'll ask my friends.'* *'over Facebook or something like that. They would all work at the same time; just ask questions and things like that. Just sort of chat online…'* *'I know who needs help. Who can help.'*	During interviews all but two students gave examples of working with others on more than one occasion and almost 80% of students agreed with the item which focused on this in the questionnaire (mode of 2). Examples were given of some students using peer working in a very structured way, explaining that they had formed a '*study group'* with peers. Other students acknowledged they would work on their own until they encountered a problem.	36. Throughout this year I have chosen to work with others on several occasions.

Table 8: Presentation of 'ways of learning' data.

'… we worked for a few weeks on it and got 100% on that one. But quite a lot of the [people on our] course came into our study area on the last day and quite a lot of people got high scores and we'd worked for two weeks and … After about 20 minutes I actually told the people to go away. I said, 'We've worked hard on this and I don't want you taking our ideas' but we'd already basically given the ideas to a few people.'	In the second round of interviews it emerged that some students were being selective in their use of peer working and in their choices about when to share information. Almost half of all those in the sample disagreed that they were careful about how much information they shared, while 30% were unsure and 23% agreed.	37. I am careful how much knowledge I share with other students.
'Yes [spending an hour each week on a subject], it worked really well last year so… I mean, I don't think I can improve on what I did last year, so if I just keep to the same standard I'll be over the moon'.	Some students gave examples of having done more study during their second year, whilst others felt they had done roughly the same as in the first year. There were no students interviewed who felt that they had done less work. The quantitative data shows about 60% of the students have done more work this year than last year (item 38 - mode of 2).	38. I've put more hours into my weekly studying compared to last year.
'*I think it's, not so much drifting off, it's just that we're not finding the need to as much...'*	Some students reflected on the fact that they had not needed to engage in as much peer working as they had in their previous year of study. When asked whether students felt a greater need in the previous year to ask friends for help than in the second year, a large number of students were unsure or neither agreed or disagreed (mode of 3).	39. Last year I needed to ask my friends more about how to tackle work.
'You see I find that I'm quite good at that subject so I'm not trying as hard, and maybe I shouldn't do that because I might just be leading myself into a false sense of security.' '*I mean, that was probably the easiest one to do as well, you know, out of the three that we've had… I think I put more effort into the rest, and then by the time it came to hand it in I was just 'Oh, I still haven't done that and haven't done that…' and tried to rush them off.'*	Students' perceptions of their own abilities within a subject influenced their study. This was evidenced by some students admitting that for easier tasks they were not putting in as much effort as they would for more difficult tasks. In the questionnaire this was explored and about 45% of students agreed that when an assessment task is easier they find they put less effort into it and don't do as well as they could (mode of 3) .	40. Sometimes when a task is easier I put less effort in and don't do as well as I could.

Table 8: Presentation of 'ways of learning' data.

'We were on the same kind of level and we were sitting quite close to each other in class and it was good working together because there were a few things I didn't know and I would have maybe spent more time on in class and he would help us (sic) out, and vice versa, so we kind of flowed through all the class and all the tutorials...' *'I'd ask the other people on the course, yes. But if it got to the point where I really didn't know then I would go to the seminar, yes.'* '*First I will talk with friends, yes, with this problem 'Can you solve it?' and if not I would go to teachers.'*	In the interviews students explained what they do in a classroom situation if they are finding something difficult. Most students said that they would primarily ask someone they were sitting next to. The qualitative data showed that most of the students in the sample would agree with this (mode of 1). This shows the embedded nature of peer working between members of this cohort.	41. If I am finding something difficult in classes my first response is to ask other students.
'*I tend to like do stuff on my own, because at least that way I can find out…'* '*... I need time on my own. If I'm in with the study group sometimes, I'll go and sit, they might be in the basement or the library and I'll go and do a few hours' work on the fourth floor, so I'm well out of the way; that's just because I sometimes prefer to grasp a new concept on my own without people nudging me and asking me 'How do I do this?' when I haven't grasped it myself. I like working in a group but I sometimes like to develop a concept on my own first'.* *'I sometimes prefer to grasp a new concept on my own.'*	Students often chose to work with peers however they also felt they required time and space on their own to learn. Almost 75% of students agreed that they need time working on their own to really learn something (mode of 1)	42. I need time working on my own to really learn something.
' ...the group I study with, they turned 'round and asked me if I wanted to study with them, so I took that chance.'	Some students appeared to have planned out their independent study time with organised study groups while others were far less structured. 40% of students selected the unsure/neither agree or disagree option in the questionnaire in response to the statement asking if they had done more independent study than they had planned to do this year. 35% felt they had done more and about 25% felt they had done less (mode of 3).	43. I have done more independent study than I planned to do this year.

Table 8: Presentation of 'ways of learning' data.

'I haven't put anywhere near as much time into Business and Manufacture. And Mechanics is taking most time, sorry, Mechanics combined with Design actually, but that's just the nature of it because we're continuously being assessed in Design so I think it's got its good and bad points. It takes up a lot of time. But at the end of the year, we're allowed to concentrate on one less exam when we're revising so I actually like that layout.'	Students discussed which subjects were taking up most of their time, explaining that their time is not evenly distributed between subjects. This was explored further in the questionnaire and students agreed that they had done more independent study for Mechanics and Energy than other subjects (mode of 1). The quotes give an example of how independent study was 'for one student' directly related to assessment.	44. I have done more independent study for Mechanics and Energy than other subjects.
'But that was mainly down to working with the team, like, with my mates and everyone, we all put something into it. So we all got to work it out together.'	Students gave examples of how working with peers had allowed understanding to be developed. The results to this question showed a modal value of 1.	45. Talking with other students helped develop my understanding.

Table 9: Presentation of 'assessments' data.

Example of qualitative data	Description/context	Questionnaire Item
'*I just do, if we've got anything marked…"* '*I've certainly spent a lot of time doing [Energy, Maths and Design} but because of the assignments...'*	In the interviews students mentioned that their design module, with its continuous assessment technique, had taken them a significant amount of time. This notion was explored qualitatively with students being asked which subjects they spent the most time on in a typical week. Approximately 85% of students reported that their independent study focussed on the assessments tasks they had been given during the year (mode of 1).	46. During the year my independent study mostly focussed on what was assessed.
***'...** by the end it had got to the stage where if I didn't have the formula I needed I knew enough theory behind it to mix and match and pull bits 'round'* *'always want to see how it goes, like, how the formula has been arrived at… because actually formulas, you can forget, but how it comes you can remember, so when you see this problem, I think it's a better way, it's more interesting as well, like, to know, you can add everything together to one understanding.'* *'I gave up halfway through trying to understand it, just started to memorise formulas...'*	Approximately 50% of students agreed that they often make use of formula to solve problems without understanding the theory, or without even trying to understand the theory (mode of 2). 30% disagreed with this statement indicating that there are a relatively high proportion of students who do try to understand the formulas they use. The quotes show the diversity of approach.	47. I often use formulas without trying to understand the theory.
'After about 20 minutes I actually told the people to go away. I said, "We've worked hard on this and I don't want you taking our ideas"'	Students reported examples of being asked for help by other students when it was near to a deadline. This item gave a mode of 1, showing a large number of students did have poor time management of tasks which led to them seeking peer support near to deadlines in order to complete work. This appears to have caused some tensions amongst students, as demonstrated by the associated quote.	48. At least once this year I have left work until near the deadline and had to ask other students for help.

Table 9: Presentation of 'assessments' data.

I've got that at home actually, but I never look at it. I know I should be more organised. I was organised enough to get everything and print it out…'	Students are provided with an assignment schedule by their course leader. Students described how they made use of this; ranging from very structured use to help manage time to students who did not use it at all (shown in the quote to the right). Almost 60% of students stated in the questionniare that they made use of the assignment schedule to help them plan their work (mode of 2).	49. I used the assignment schedule to help me plan my work.
'*I would say labs and the class tests should be worth more, for the amount of work that you do for them as well'* *'…when you have the overlap of the labs and the exams coming up and I would try and revise but I'd have a lab to do as well and you've got to try and balance yourself out...'*	The qualitative stage provided examples of students explaining that they don't always feel that the effort they put in to their work, and the learning they achieve, is reflected by their marks. Almost three quarters of the sample agreed that the amount of learning they felt they achieved was not always reflected by the marks awarded (modal value of 2).	50. My marks so far are reflecting my effort and my learning.
'No, I need time on my own. If I'm in with the study group sometimes, I'll go and sit...well out of the way; that's just because I sometimes prefer to grasp a new concept on my own without people nudging me and asking me "How do I do this?" when I haven't grasped it myself. I like working in a group but I sometimes like to develop a concept on my own first.'	Students gave examples of liking time on their own to study, for example, in preparation for tests. The quantitative data allowed this to be explored further and it was shown that almost three-quarters of students agreed that they prefer preparing for tests on their own (modal value of 1).	51. For tests I like to prepare on my own.
'... the ones that are not so good are kind of sticking in their little group.'	The questionnaire was used to further explore the data provided in the qualitative stage and showed that over three-quarters of students chose to discuss work with others at a similar academic level to themselves (mode of 2).	52. I often discuss assignments with others who are at a similar academic level as me.
'Well the main ones I have to concentrate on is Maths, Mechanics and Energy.' *'Because Mathematics, actually what we do in class I see in tutorials, just solve it and it's covered, I don't need to read so much about it, if you understand it '*	This question was developed to see how assessment preparation would be influenced by the concepts of difficulty and importance (as shown in previous quotations and questionnaire items). The qualitative data suggested Mechanics and Energy would be focussed on most as they required understanding of a higher degree than maths. Approximately 70% of students stated that they are planning to concentrate on Mechanics and Energy for the exams (mode of 2).	53. I plan to concentrate most on Mechanics and Energy for the exams.

Table 9: Presentation of 'assessments' data.

'...towards the end, like, the beginning of the exam times, I would check the other books. ' *'No. I bought all of the books that were recommended to me for every subject, and actually found when I came to assignments and stuff, it was handy having them there to go away, but in some subjects more than others, I'd consider it almost vital to have the books, just for the amount you're expected to cover a lesson, it's not enough.'* *'"it's not like we can go and pick up a book and it'll be his syllabus. It's his slides, his syllabus, he's doing it, it's not even 'Do further reading' so basically if we get tested on it we do whatever the slides say...'*	The preparation for (and the completion of) assessment tasks was investigated and students were asked about how they had found the information they needed to complete tasks. The questionnaire showed that about 50% of students felt the handouts provided in lectures had been enough to help them do the assessed work (mode of 2). About 30% were unsure/neither agreed or disagreed and about 20% disagreed with this statement showing that for most assessed work they had needed to refer to material other than that supplied in the class. Some students did find it restrictive when staff taught solely to their handouts rather than textbooks.	54. The handouts have been enough to help me do most assessed work.
'b*ecause an assignment is a list of something you need to do. I could not turn up to that lecture all year, get an assignment, go to the library and probably get 65% on that. In a class test, you have to go to those lectures, you have to do tutorials. So assignments are nowhere near as good for keeping someone up to speed and making them do work, as class tests are.'*	In their first round of qualitative data collection students felt it was unhelpful that they didn't have class tests in their second year. The questionnaire item was agreed with by 70% of the sample (mode of 2). This may suggest that towards the end of the year (when the questionnaire was completed) students recognised the benefit of assignments.	55. Assignments have helped me learn as much or more than class tests.
'*... I don't know whether that's because in first year I remember doing them all, then when I came to revise them I went to do them again, and obviously I just knew them...'* *'Because I am stressed about Mechanics there is so much I need to do, to look in the book, I must do almost all the tutorials, I've done a few but there is a lot to do, each day at least two hours spent on Mechanics I think.'* *'I'm trying to leave quite a few of them for revision as well.'* *'I think [the lecturers] give you a kind of variation where the most difficult the question can be ... as long as I make sure that I can fully understand those. But my plan is to do the tutorials again, or I want to do them again as part of my revision.*	The quantitative data supports something which was implied during the interviews; students aren't necessarily trying to develop a full understanding through the year and assessment may be influencing this decision. Some were waiting to use tutorial problems for revision, some planned to use tutorial questions twice, and others were using them as a method to learn difficult subjects. Over 65% of students said they were leaving tutorial problems until the end of the year so that they can use them for revision (mode of 2).	56. I am leaving tutorial problems until the end of the year so I can use them for revision.

Table 9: Presentation of 'assessments' data.

'I don't know how the assessment worked. I think you winged it really.' *'I think there's this test and then I think there's an assignment, I'm not sure.'*	Students gave examples of times when they weren't exactly sure how they were assessed. Despite this, in the questionnaire it was positive to see that almost 70% of students felt most of their learning outcomes were actually clear to them (mode of 2).	57. It was clear what was expected in the assessed work for the course.
'Just really a mark and maybe some scribbles here and there, like an exam paper would be marked, random, small comments.' *'We had a lab report which... I can't remember; we got it back last week. I think I did all right in it.'* *'I believe I picked up some strong sort of hints and tips...'*	About 50% of students felt that most feedback had been beneficial in moving their learning forward. 30% were unsure/neither agreed or disagreed and 20% disagreed (mode of 2). It was also interesting to note that some students could not recall whether they had in fact been given feedback which may suggest some feedback is not making an impact on students at all.	58. The feedback given on assessed work helped me to improve my learning and studying.
'because once I've done it I just think, 'Right, well that's out my head and I've got something else to concentrate on now.' *'…I think I thought, 'Right, I'll just get my head into it and do it and do it as often as I can' hoping it would click. At the time it was pretty much a case of tape in, tape out, so I learnt it, what I'd need to learn that time, sit the test, and then almost erase the memory and then picked up the new stuff, you know, so there was no strategy, it was just about getting through the test and getting the grades that I needed.'*	Students in the interviews gave examples of a subject that they were aiming to just pass rather than really understand. This was explored through the questionnaire as it is not within the aims of the course to enable students to pass without understanding. Disappointingly almost 60% of students agreed that this was the case (mode of 1).	59. There is at least one subject that I'm aiming to just pass rather than really understand.
'I need that sort of thing, it motivates me and gives me an idea of where I am. Without that, it's a bit scary if I feel like I'm doing less work because of that.'	In the first and second round of interviews, students were asked how they found not having class tests in Mechanics and Energy in second year as they had done in first year. The quantitative data showed that there was a mixed view on this with around 45% agreeing, about 25% unsure and around 30% disagreeing (mode of 3). Although the view was mixed it does show that in line with some of the interviews that it is difficult for some students to judge their own progress.	60. Lack of class tests has made me unsure of my progress this year.

'You can't pass an exam without having a good understanding of the module where you can hand an assignment in and get a high score without really understanding it.' *'Yes. As long as I pass Maths I'll be happy. I'm not expecting to get a really high grade in Maths but as long as I get 50% I'm fine.'* *'I just want to get it done and out the way with so I don't have to see it again.'* *'I might only get it enough so I can then say 'Right, fine. Done it' not actually choose it in the exam.'*	Almost three-quarters of students admitted that they prepare tactically for some exams. This shows that although students as a whole cohort identify that they apply deep approaches to their learning, there are still aspects about their assessment that they will approach tactically.	61. I am going to be tactical in choosing what to prepare for some exams.

Table 9: Presentation of 'assessments' data.

Table 10: Presentation of 'University staff & structure' data.

Example of qualitative data	Description/context	Questionnaire Item
'...other members of staff come in and nothing would happen and you'd be like, 'Why? It's Friday and I might as well be at home or might as well go out, chill out for the weekend, but I'm here wasting my life.' *'You see it doesn't really, it kind of affects us, I think it's affecting us, it annoys us a little bit and gets us frustrated, but I want to do really well in every subject so I know if I'm not getting the help I need I just need to concentrate on that subject more and I don't think it will affect how much effort I put in.'*	Although some students have shown that they are responsible for their own learning, the effect of poor teaching can still be seen in the response to the statement 'I put less effort into subjects when I don't think the lecturer teaches well.' Almost three-quarters of students agreed that their experiences of teaching affects how much effort into a subject (mode of 1).	62. I put less effort into subjects when I don't think the lecturer teaches well.
'I just feel that sometimes, you know, we come to university and we look at the lecturers as someone who has been in our position before, they know exactly how we feel, they might not have been in the industry but they've definitely been in education and they've thought 'Oh I want to take this higher, I want to teach somebody else' and sometimes I think the professionalism just isn't there, that, especially me and some of the younger people look for guidance in. I mean timekeeping, some of the lecturers turn up late and I think that is really bad and I just think it's because I want to be a professional in my field and I want to get a Chartership and go up to management...' *'I find him unprofessional, the way he dresses, how he turns up, how he holds himself...'* '*…he's a good tutor but he can be a bit unprofessional sometimes. There's a few times in class where he kind of looks down on you a little bit, which I suppose yes, he's understood it, but he should be trying to help you get through it,'*	Students' expectations of staff were prominent in both rounds of interviews with students judging interactions with staff based on their expectations about how they should organise their teaching, how they should offer support and how professional they should be. An example of a lecturer who commanded respect was given. The questionnaire results showed the responses had a modal view of 1 (78% of students agreed with the statement) which suggests the majority of the cohort agreed that their effort towards a module was affected in some way by how professional they felt staff were.	63. Unprofessional staff (e.g. poor timekeeping) affect how seriously I work towards a module.

Table 10: Presentation of 'University staff & structure' data.

'...nice to have the tutors that take the time to go through the questions after so that you can go away and pick up where you went wrong.' *'... [Lecturer] , he teaches you whatever, and you know that you can go and refer to his [core text] and know that there will be something similar that you can work through, although not exactly the same, but you have that guide there'* *'his lesson structure was pretty good, yes, he explains a load of stuff at first and then finished off by working through an example with us... That's exactly what you need.'* *'…he's been very helpful, he's not told me to leave or anything because he's not had time, so for me that's good enough.'*	The majority of students agreed that interactions with most staff had been beneficial to their learning (mode of 2). In the qualitative study several examples were given of teaching that students felt supported their learning, for example, students appreciated the structure some staff had in their teaching	64. Interactions with most staff have been beneficial to my learning.
'So I think it's a bit more, it's pushed back onto ourselves now and say "Look you have to deal with it, you plan it yourself, you're responsible.""	Students were mixed in their views regarding their need for direction and support from staff. Just under one third of the students involved in the questionnaire data collection agreed that they need less direction this year than they did last year (mode of 4). Approx 40% of students disagreed and about a quarter of students neither agreed nor disagreed.	65. I need less direction from staff this year than last year.
'*it's an hour's trek each way for me to come up, and this was the problem I had last year when lecturers were saying, 'If you're struggling, come and see me' and I was like 'I can't come and see you any other time. I'm here in [University] for one day a week and other than that I live 40, 50 miles away so it's a hassle to come and see you any other day.'*	Part time students, more than full time students, explained in the interviews how they struggle to find time to ask staff questions. Just over half of all students in the quantitative study indicated they do find it difficult to find time to ask all the questions they have (modal result of 3). This indicated that some full time students must face this difficulty in addition to part time students. A significant number chose the unsure/neither agree or disagree option which may also indicate these students did not feel they had any questions which they needed to have answered and therefore could not chose a suitable agree/disagree response.	66. I find it difficult to find time to ask staff all the questions I have.

Table 10: Presentation of 'University staff & structure' data.

'*this year is just a constant stream of assignments.'* *'... then it was summer holidays… I pretty much chilled out about everything and I seem to have learned or understood more or it seemed to make more sense in that 3 months off. So I came back understanding better. You know, I guess it's no stress, and I was just carrying on with life, so probably because I was so stressed in the first year I didn't really pick up much or I wasn't learning as well as I am now.'.*	Students gave examples of times when they felt the workload was heavy. Around 60% of students felt that the workload had been too heavy at times for them to really learn (modal value of 2). An example was given by one student of how having space (away from a heavy workload) helped their learning.	67. The workload has been too heavy at times for me to really learn.
'If we're talking timetabling, it would have been more helpful instead of having so many subjects spread out across the week, to maybe condense everything into, you know, 2 and a half days as opposed to the odd lesson here and there, which would give me more block time to do stuff.'	There were examples in the interviews of students who felt that not all timetabling was ideal, however over half of the students completing the questionnaire felt that the timetable was set up in such a way to allow them to do their own studying around lectures (mode of 2).	68. The timetable has made it easy for me to do my own studying around lectures.
'But when we all start thinking we need to revise, we will be doing it together, there's no doubt. We'll probably pick one of the classrooms like we did last year using the projector and the library rooms and that pen board, because that was awesome last year, the Smart board.' *'.... I quite like using blackboard [eLP].'* '*I think I haven't trained myself to actively use it [eLP] yet. .... I think it would be useful to use more often but I haven't quite got to the process of actively looking at it every day.'*	Almost two-thirds of students felt that the rooms and resources provided by the university were beneficial to their learning (mode of 2).	69. Access to rooms and resources has helped me learn.
'...He doesn't even tell you which book to look for, doesn't tell you anything; just goes, 'Right, go in the library and try and find some stuff for yourselves to read.' *'.. you know that you can go and refer to his [recommended text] and know that there will be something similar that you can work through...* '*When I first got the question... I looked at this and really didn't have a*	Although there were examples of students who felt the support they received from staff was very helpful to their learning there were others who felt annoyed when they didn't receive the support they expected. A significant number of students agreed (mode of 1) that it hindered them to be referred to a book rather than being supported directly by staff. The qualitative data however showed that some students appreciated that staff would expect them to develop their own learning.	70. It hinders my learning when staff refer me to a book instead of giving me the answer.

Table 10: Presentation of 'University staff & structure' data.

clue. And [the lecturer] was really good in the fact that he didn't help. He said 'Just go away and think about it' and I was frustrated and I spent a lot of time on it. He would give the odd point if you were along the right lines, but I think that was really good because it was a good feeling, finally getting the marks…'		
'[subject] which I find quite interesting but a really short block about it and he doesn't expand on it as much as I reckon he should'. *'I must read a lot on my own, so we are meeting in the library and talking about it. So actually the lessons are just a waste of time'* *'He doesn't seem to have much structure... he seems to go off on one topic and then come back.'*	In contrast to the positive examples of teaching and support for learning there were still occasions where students felt that the quality of some teaching hadn't been what they had expected; modal value of 1.	71. The quality of some teaching hasn't been what I expected.
'You see it doesn't really [make a difference], it kind of affects us, I think it's affecting us, it annoys us a little bit and gets us frustrated, but I want to do really well in every subject so I know if I'm not getting the help I need I just need to concentrate on that subject more and I don't think it will affect how much effort I put in.' *'but this year I am a bit stressed about [subject] because I don't know, I know it, but from the teacher I don't get so much help so I must do a lot myself.'*	Most participants appear to be taking the responsibility for their own learning further with two thirds in the quantitative study stating that they ensure they do their own study if they feel teaching of a subject has not been ideal (mode of 2).	72. If teaching isn't ideal I ensure I understand the material by doing independent study.
'we're missing a few seminars this year, which, I'm not really happy about.' *'seminars are good when you can engage with a lecturer.'*	There were a number of participants during the first round of interviews who were unsure about how having fewer seminars would affect them; in round two some of those participants felt that they had not been adversely affected by lack of seminars. In the quantitative study the results showed a spread of opinions (mode of 4), with about 45% feeling that staff don't do enough examples in class and that they still need seminars, about 25% were unsure and about 30% felt they staff did enough examples and seminar sessions weren't needed.	73. Most staff do enough examples in their classes so I don't need seminar sessions.

. Table 11: Presentation of 'personal' factors data.

Example of qualitative data	Description/context	Questionnaire Item
'I think second year, you need to step up your determination' *'I think a lot of it has to be independent as well. The lectures that are being done are being done well. Again, I think it's the part where you have to go away and start looking at it yourself…'*	Several students expressed clear perceptions about the way they felt second year Mechanical Engineering students should behave and were disappointed when they did not see peers behaving as they felt they should. The quantitative data showed that almost all students actually felt that they should be more responsible for their own learning in the second year of the programme (mode of 1).	74. Second year requires you to be more responsible for your own success than first year.
'*... I changed my lifestyle last year and I became a 'student' in the sense of my study, you know, for the whole year...'*	Students in the qualitative stage gave examples of making decisions about their studying and their behaviour within classes. Item 75 was developed to explore whether the majority of the cohort felt they actively made decisions about the type of student that they were. Results showed that most students agreed that they did actually make a conscious decision about the type of student they were (mode of 2).	75. I have made a conscious decision about the type of student I am.
'I just think they don't need to [check with others] as much, you're getting the hang of it so can plod on a bit.'	This question was developed leading on from the fact that students discussed that they needed to be more responsible for their own learning and that they felt less need to ask others for support during their second year. Students agreed that they generally did feel more confident (mode of 2).	76. I am more confident in my own ability this year.
'I'm enjoying it a lot more actually. I didn't enjoy the first year.'	Although some individuals gave examples during the interviews of areas of the course that held no personal interest for them, the quantitative data allows it to be seen that these instances of disinterest are only small within the scheme of the whole programme of study. Compared to their first year about half of the students said they had also enjoyed second year more, while around 30% neither agreed nor disagreed and 20% disagreed (mode of 1).	77. I have enjoyed this year more than first year.

Table 11: Presentation of 'personal' factors data.

'When we've got a lot of deadlines coming up, I see a lot of my classmates are stressed, and I just see that as a chance to prove myself, get myself organised and maybe that's going to be the point where I can set myself apart from other student sometimes, so I actually like the challenge.'	During the interviews one student reflected on the high workload and explained he felt it was a '*chance to prove'* what he was capable of. However, when the quantitative sample were asked whether a high workload was a chance to prove themselves there was a very mixed response with 43% agreeing or agreeing somewhat, 20% stating they were unsure (neither agree or disagree) and 37% disagreeing somewhat or disagreeing. The modal response was 4, showing that the cohort as a whole disagreed somewhat with the statement, suggesting that most saw high workloads as a negative factor rather than a welcomed challenge.	78. I enjoy high workloads and difficult tasks as a chance to prove myself.
'I would say labs and the class tests should be worth more, for the amount of work that you do for them as well.'	Students gave examples in the interviews of times when they felt like the effort they put into their work wasn't reflected by the marks allocated for the assessment task. A mode of 2 indicated that the cohort agreed somewhat with this statement.	79. When I feel like I've learned a lot it doesn't always show in my marks.
'put in more this year… The more you get this year the less you have to do next year, well, it counts towards…'	Students made several references during interviews to the fact that second year 'counted' towards their final grade. Over three-quarters of students agreed (modal value of 1) that they are more motivated to do well in the second year because the year counts towards their final award.	80. I am more motivated than in first year because this year counts towards my final mark.
'There's a few lads had different personal problems, and it does affect you...'	The qualitative data suggested that a number of students had personal issues which had affected their studies over and above their experiences at University. Over half of the students agreed with this (mode of 2) serving as a reminder of the wider context in which students exist and that the university experiences may only be a small part of that person's whole learning experience.	81. Personal factors have had more negative affects on my learning that anything at University.
'If there was stuff I was stuck on, I wasn't particularly that bothered, but once I'd even had the first group of class tests for every subject, I thought, "This isn't something you can ignore..."'	This item was developed in line with item 56 and derived from students discussing that they leave tutorial problems, and therefore some learning, until the end of the year. Over half of the students in the quantitative sample agreed with this	82. If there are small things I am unsure of I wait until I revise for exams to try and understand them.

Table 11: Presentation of 'personal' factors data.

	approach (mode of 2), which suggests that there is not necessarily a culture of always attempting to take a deep approach and that students are selective about which things they allow to 'slip past' without having a full understanding of during the year.	
'*I think the Mechanics… I'd have to put 'Mechanics' and 'Energy Conversion and Systems' together, and I don't think I could really pick one over the other and not just sitting on the fence. I don't see one as more important than the other. Maths, I think that's a good tool just to build on problem solving, which helps in the other modules.'* *'Maths, Mechanics and Energy. I see them as core modules; if you fail them you shouldn't be doing the course.'* '*Yes. Because the top three [subjects; Mechanics, Energy and Maths], I'd say, to become an engineer you have to prove you can do this; and I'd say the bottom three [Design, Business & Manufacture, Professional Skills] are there to make you a better engineer.'*	During the interviews students struggled to pick just one subject which was more important than others, however mechanics and energy were frequently discussed, with maths often being discussed slightly behind. The quantitative data shows that the cohort in general were also unsure, or neither agreed of disagreed (mode of 3). Looking at the figures for the responses provides more detail on this occasions showing that about half of the students in the quantitative sample felt that mechanics and energy were more important than other subjects this year.	83. Mechanics and Energy were the more important than other subjects this year.
'…I can't really be seen to fail so there's an element of my own pressure and then work pressure, so a fear of failing means my career, that's pretty much it.' *'My motivation is to progress as a professional engineer. I do think about that pretty much every week so that's my motivation on a daily basis as well.'*	Almost all (mode of 1) students in the quantitative sample agreed that they were motivated primarily by a fear of failing. It is acknowledged that this is a complex issue and that there may be many reasons why this is true. The qualitative data allowed for some suggestions to be made about the specific reasons for these fears such as funding and employment factors.	84. I am motivated by a fear of failing.
'Just before Christmas, just really running out of steam and people getting sick.'	The quantitative data agrees with some instances of qualitative data where students expressed their difficulty in maintaining motivation during the year, a modal value of 2 was present for this questionnaire item.	85. I have found it difficult to maintain a constant motivation & effort through the year.
'It's quite a bit harder, the work. I don't feel as confident with the stuff we're learning,' *'... although I'm still not great at it I'm certainly understanding more.'*	When asked during interviews how students were finding second year overall compared to first year, most students felt that second year was more difficult. The quantitative data showed that students agreed that the subject material in second year is more difficult (modal value of 1).	86. The subject material is much more difficult this year.

Table 11: Presentation of 'personal' factors data.

'I think the course is going on to more difficult things. The first year, I did a lot of Engineering in college so a lot of it came up again. It seems more advanced and more taxing, which is good.' *'… it's a lot of just numbers this year, it's just equations, whereas last year I was getting a bit more, you know, it seemed more interesting, … I know you've got to get all the theory stuff out the way but… second year is pretty much the plodding bit …'*		
'we just take notes…' *' ...so you copy that down on your notes.'*	In the qualitative study several students referred to handouts they were given and how personally active they were in classes e.g. adding notes to any handouts. The questionnaire shows this to be the case for most students and that very few students sit passively during classes (results show a mode of 1).	87. I often write extra notes or add my own notes to handouts.
'I mean, for me, I'm finding that quite interesting right now' *'...it's quite interesting some of the stuff that he's teaching us.'*	There were several instances when students discussed aspects of the course as being interesting, this supported the development of item 88. A number of students identified that they found the most of what they had learned interesting (mode of 2).	88. I found most of what I learned in this course really interesting.
'[second year is] better than last year. Definitely. Just I think a bit more work.'	The quantitative data shows that the actual workload appears to be in line with students' expectations with item 89 obtaining a modal response of 2.	89. The amount of work I was required to do was what I expected.
'sometimes it was time constraints' *'Nothing ever satisfies, honestly nothing will….., I have to cut myself a limit, and just say 'Look this is the deadline, this is in' and if it's not to my ability before then, then I'm going to have to learn to be better in a shorter amount of time.'*	In the interviews completion of work was explored and students were asked how they decided when they had done enough work on a set task. In response to this, students explained that they often stopped due to time constraints rather than being satisfied with the quality of their work. This issue was explored in the quantitative study and almost half of the sample agreed that they were rarely satisfied that there work is as good as it could be (mode of 2).	90. I am rarely satisfied that my work is as good as it could be.

5.6 Rating of Achievement

To support the interpretation of the results, and the context in which they were given, students were asked overall how well they felt they were doing. It is suggested that responses from students who all felt they were struggling on the programme may be very different to those who felt they were achieving to a standard they were happy with. Students were asked to rate their own achievement on a scale of 1 – 9 where a score of '9' indicated students felt they were doing 'very well' and a '1' indicated students felt they were doing 'rather badly.' Based on comments and marks they had received most students (85%) felt they were doing well, quite well or about average. The breakdown of responses are shown in Figure 12.

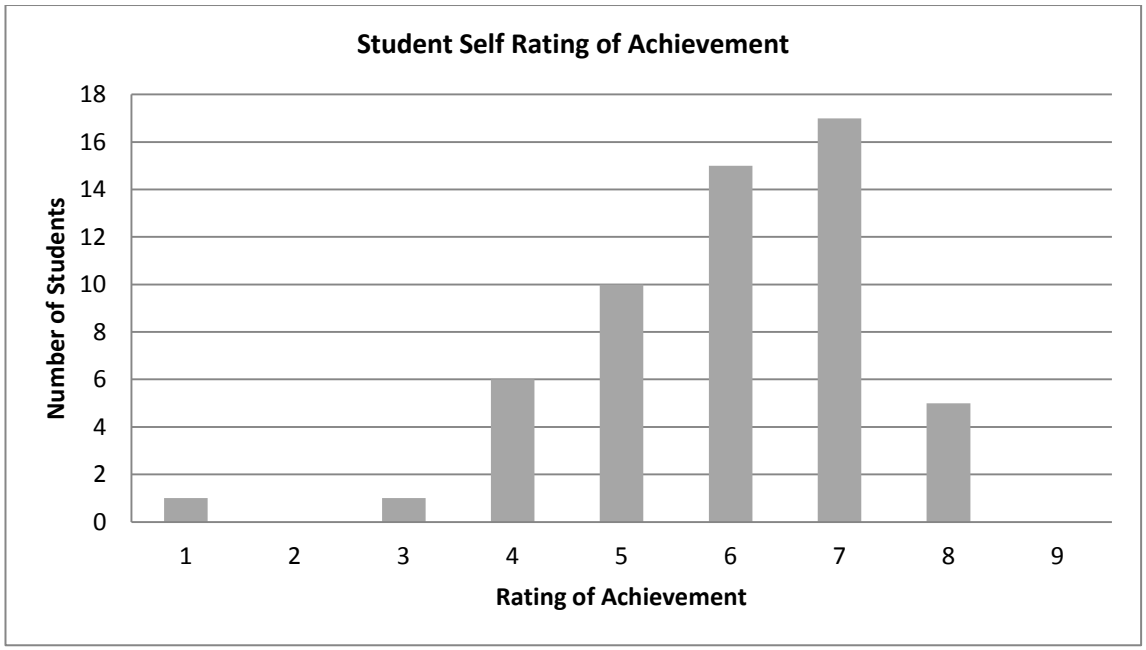

Figure 12: Student Self Rating of Achievement

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5.7 Summarising the Description of the Integrated Results

The description and integration of the data demonstrates the vast number of items which students discussed in relation of their teaching and learning. Whilst the findings have been organised in terms of the somewhat arbitrary questionnaire categories, upon reading of the information it can be seen that there are substantial areas of overlap between the categories. This highlights the complexities within, and integrated nature of, the teaching and learning context.

5.8 Further Exploration of Questionnaire Data

As mentioned in section 5.4 the majority of statements in the questionnaire were agreed with by the cohort in general. The fact that the cohort were in agreement with most

items from the questionnaire suggests that the mixed methodology was strong in terms of using the quantitative data to confirm the qualitative data. It is assumed that potentially more can be learned about the cohort from the items that they all did not agree with than the items which they did agree with. Based on modal scores all items on the questionnaire were either agreed with, or agreed with somewhat, apart from those item numbers listed below:

Mode of 3 (unsure/neither agree nor disagree): Items - 9, 26, 37, 39, 40, 43, 83, 66, 60

Mode of 4 (disagree somewhat): Items - 15, 65, 73, 78

Mode of 5 (disagree): Items - 7, 19, 28

5.8.1 Statements 'Disagreed With'

The modal values showed that students only strongly disagreed with a small number of statements (3/90) on the questionnaire, shown by Figure 13.

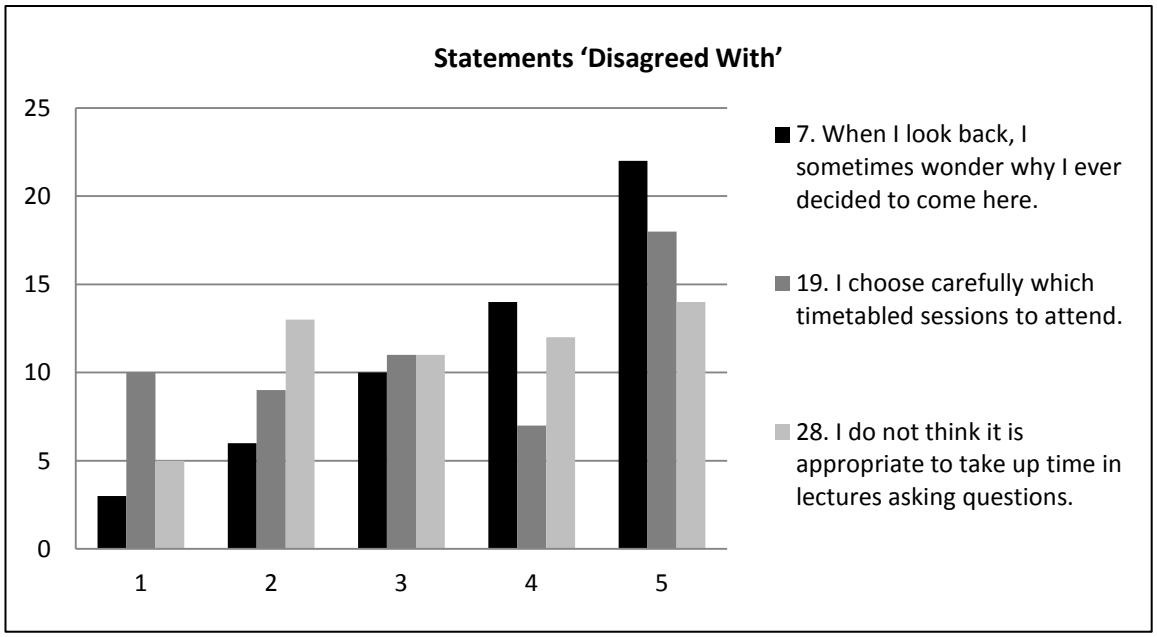

Figure 13: Responses for items 7, 19 and 28

The first statement (item 7) was one of the questions drawn from the SETLQ (ETL-Project, 2005). This item explored whether students felt a lack of purpose in their learning, as the data shows the students disagreed with this. This is a positive result, demonstrating students see purpose and value to being at the University.

The second (item 28) showed a contradiction to the interview data. Several students said during interviews that they would not ask questions in lectures as they felt it wasn't appropriate. In response to 'I do not think it is appropriate to take up asking questions' students disagreed strongly. This item shows the strength of the mixed method study, if

conclusions had been drawn on the interview data alone the perception of students regarding their questioning behaviour may have been limited.

Item 19 was developed from the perception of several of the students interviewed. Although in the interviews most students said they tried not to miss any sessions the sample did acknowledge that they saw peers whose attendance was not excellent. The statement 'I choose carefully which timetabled sessions to attend' was written to determine whether most of the cohort are in fact selective over their attendance? The cohort in general disagreed with the statement.

5.8.2 Statements 'Somewhat Disagreed With'

There were only four items that the student cohort disagreed with; these are shown in Figure 14. The first, item 15, was one taken from the SETLQ (ETL-Project, 2005) and the other three came directly from the qualitative phase of the study.

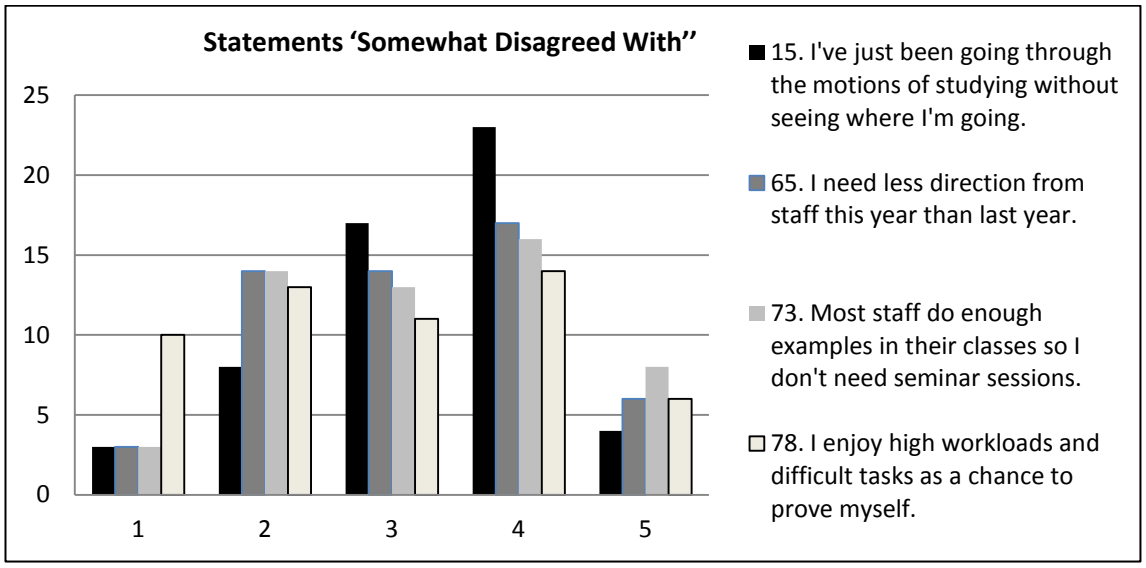

Figure 14: Responses for items 15, 65, 73 and 78.

Item 15 demonstrates a surface approach to learning. Although students agreed somewhat that they 'were more confident in their own ability this year' they then disagreed somewhat with item 65 which asked if they needed 'less direction from staff this year than last year'.

One student in particular mentioned that they saw high workloads as a challenge but most of the cohort disagreed somewhat with item 78 'I enjoy high workloads and difficult tasks as a chance to prove myself' showing that the interview data did not reflect a commonly held view.

The seminar pattern had changed from first year to second year and staff had been encouraged to do more examples in the classroom so that seminars were not needed as

much by students. In the interviews many of the part time students were not happy with the new arrangement although some of the full time students felt happy that they did not need seminars so the statement 'Most staff do enough examples in their classes so I don't need seminar sessions' was asked. The cohort generally disagreed somewhat with item 73 showing that they felt there was still a need for seminars.

5.8.3 Statements Students Were 'Unsure' or 'Neither Agreed or Disagreed With'

There were 9/90 items that students were unsure about or neither agreed nor disagreed with.

Item 9 ('Much of what I've learned seems no more than lots of unrelated bits and pieces in my mind') came from the SETLQ (ETL-Project, 2005). The item demonstrates a surface approach to learning and saw students being unsure or not agreeing or disagreeing with the statement

Five of the items that students were unsure about, or neither agreed nor disagreed about, were related to practices. These were all items which were discussed by some of the students in the interviews but not necessarily all students:

37] I am careful how much knowledge I share with other students
39] Last year I needed to ask my friends more about how to tackle work
40] Sometimes when a task is easier I put less effort in and don't do as well as I could
43] I have done more independent study than I planned to do this year
66] I find it difficult to find time to ask staff all the questions I have

Three of the items that students were unsure about, or neither agreed not disagreed about were related to their perceptions.

26] Lectures and tutorials are taught and organised in line with my expectations.
60] Lack of class tests has made me unsure of my progress this year.
83] Mechanics and Energy were the more important than other subjects this year.

		Items								
		9	26	37	39	40	43	60	66	83
Responses	1 (agree)	2	5	2	2	6	12	13	12	15
	2 ((agree somewhat)	15	17	11	16	19	7	11	16	13
	3 (neither or unsure)	19	20	17	21	20	21	15	17	18
	4 (disagree somewhat)	16	8	8	6	4	8	11	5	3
	5 (disagree)	3	5	17	10	6	7	5	4	4

Table 12: breakdown of responses for items students were unsure about.

5.9 Overall Cohort Views

Figures 15 and 16 are used to provide a pictorial representation of the items the cohort were in agreement with and also those that they were unsure about or did not agree with.

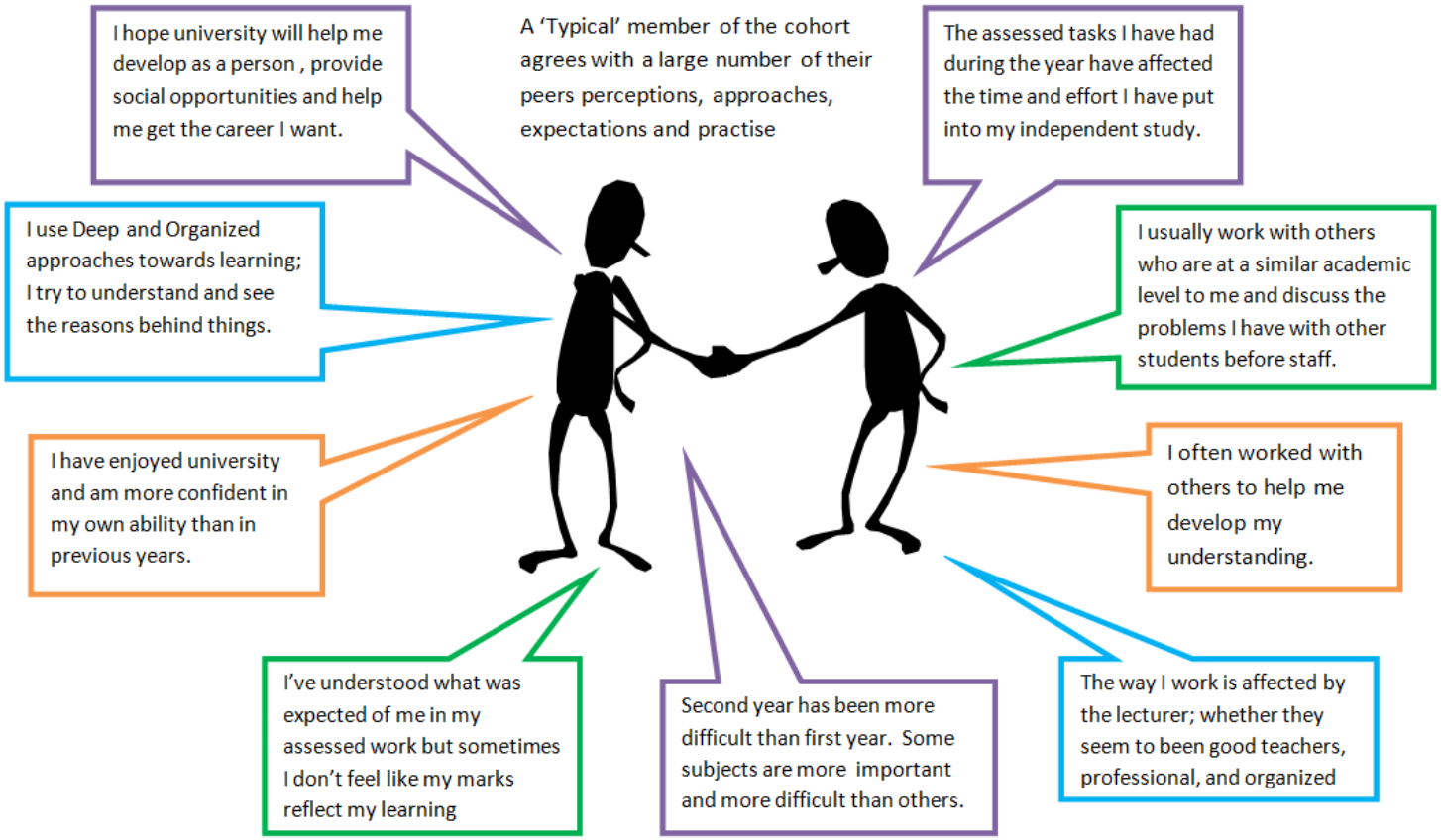

Figure 15: Items the cohort agreed with.

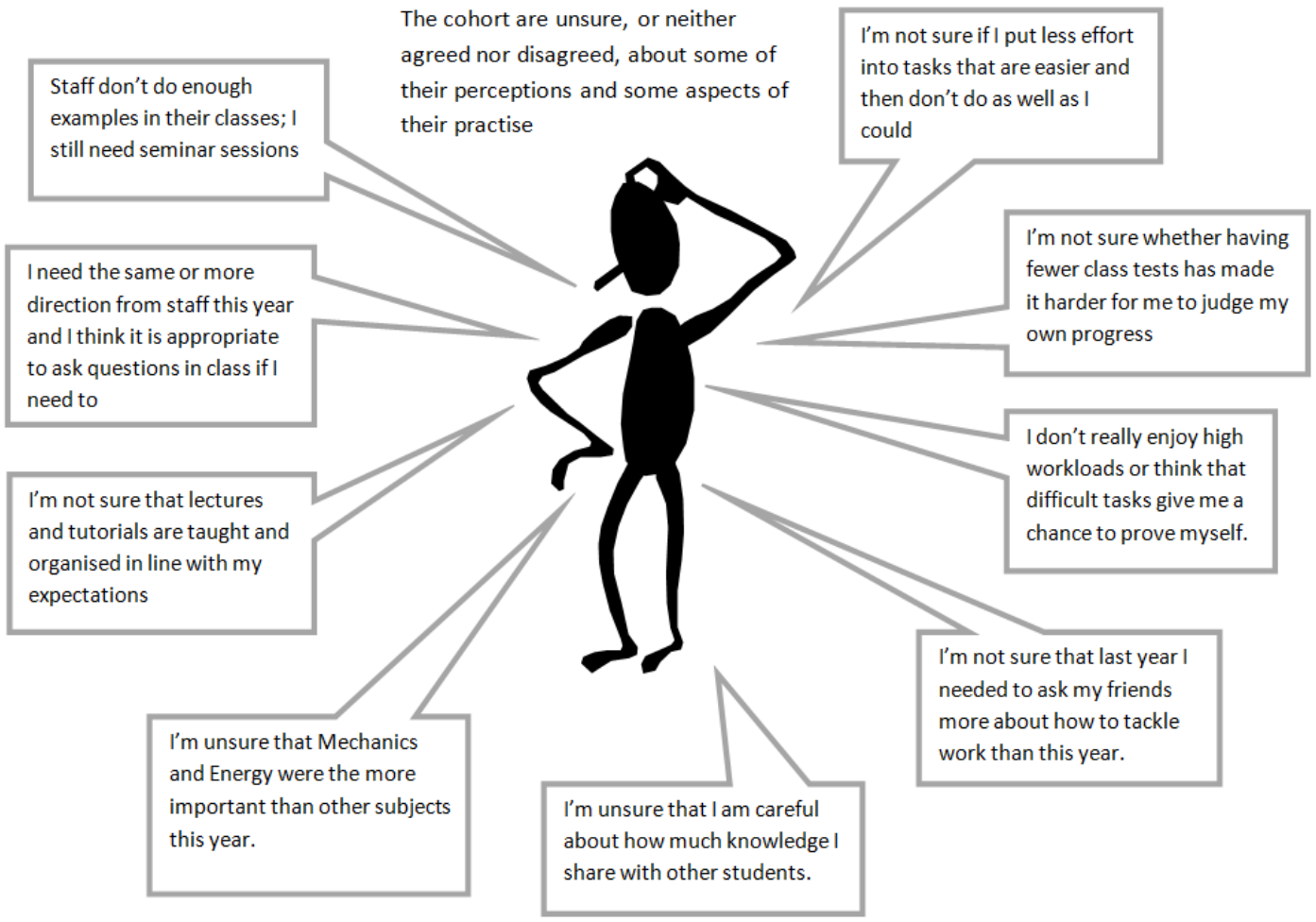

Figure 16: Items the cohort were either unsure or neither agreed or disagreed with, or in fact disagree with.

5.10 Statistical Analysis

5.10.1 Analysis of Variance

Kruskal-Wallis tests were conducted to analyse variance within the data. Analysis in this section has been carried out to consider variance in the responses of all items against students' identification of their mode of study.

Students' were asked in the questionnaire to select their mode of study, choosing between: full-time, part-time, and full-time funded. When comparing variance against mode of study 20 out of 90 item responses did show variance at a significant level (p=0.05 level).

From the questions taken/adapted from the SETLQ the questions 2, 3, 4, 12 and 15 showed some variance (Table 13). Whilst this is insightful these questions are not discussed further in this thesis, instead attention is drawn to the variance shown in the 15 questions which were derived from the qualitative data in the interviews.

	Q2	Q3	Q4	Q12	Q15	Q20	Q23
Chi-square	11.751	8.137	11.712	9.886	6.889	6.263	10.582
Df	2	2	2	2	2	2	2
Asymp. Sig.	.003	.017	.003	.007	.032	.044	.005
	Q26	Q32	Q33	Q36	Q40	Q49	Q54
Chi-square	11.978	8.427	13.340	6.267	6.587	6.463	7.770
Df	2	2	2	2	2	2	2
Asymp. Sig.	.003	.015	.001	.044	.037	.040	.021
	Q66	Q67	Q68	Q69	Q71	Q82	
Chi-square	9.705	8.350	17.604	7.327	15.571	6.211	
Df	2	2	2	2	2	2	
Asymp. Sig.	.008	.015	.000	.026	.000	.045	

Table 13: Items demonstrating variance

The 15 items which showed variance against mode of study (and came directly from the qualitative data in this study) are discussed below.

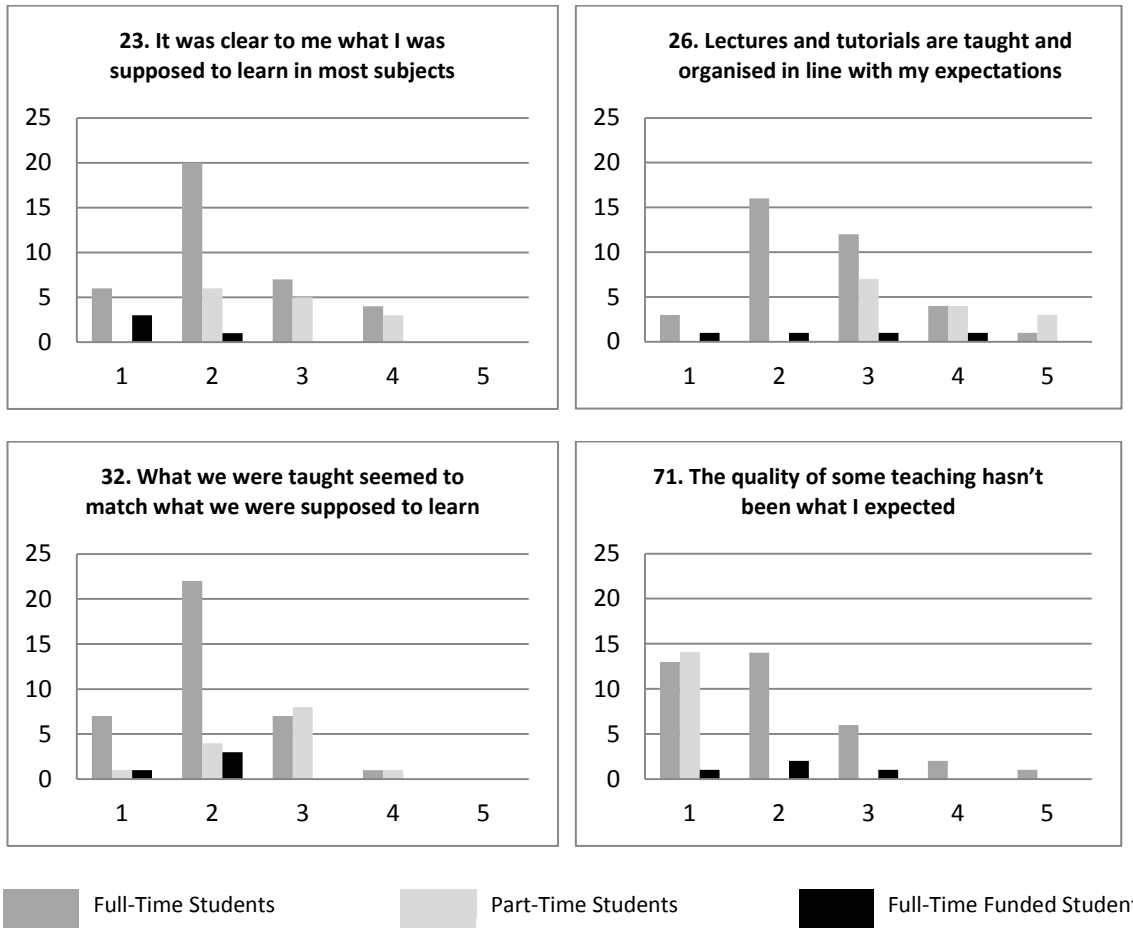

Figure 17: Results from items 23, 26, 32 and 71.

Figure 17 demonstrates the responses to questionnaire items 23, 26, 32 and 71.

Item 23 asked students whether it was clear what they were supposed to learn in most subjects. A positive skew was found for full time and funded students but a less positive response from part time students. As students are actually taught together for almost all sessions it is interesting to note this differentiation.

Item 32 asked students whether what they were taught seemed to match what they were supposed to learn - again the part time students were less sure than full time students. A similar, and maybe more distinct, difference between full time and part time students could be seen in the variance in response to item 26 where students were asked whether lectures and tutorials were organised in line with expectations. The variance shown in response to item 71 indicates that part time students very strongly agreed that the quality of some teaching hadn't been what was expected.

It is suggested that the variance observed in questions 23, 26, 32 and 71 may be related. There results suggest that further exploration is needed to understand the differences between the expectations of part time and full time students, and also how the

experience particular elements of the teaching and learning. Correlation tests (Spearman's Rho) were carried out (and are explained later in section 5.11) however correlation results related to the items which demonstrated variance are considered here. The four items (23, 26, 32 and 71) mentioned above did not demonstrate correlation with each other, however between items 32 and 23 there was a high correlation (0.662) evident and then a moderate relationship was found between item 23 and 71 (0.461), and also between item 26 and 32 (0.410). Correlation at these points was significant at the 0.01 level (2-tailed).

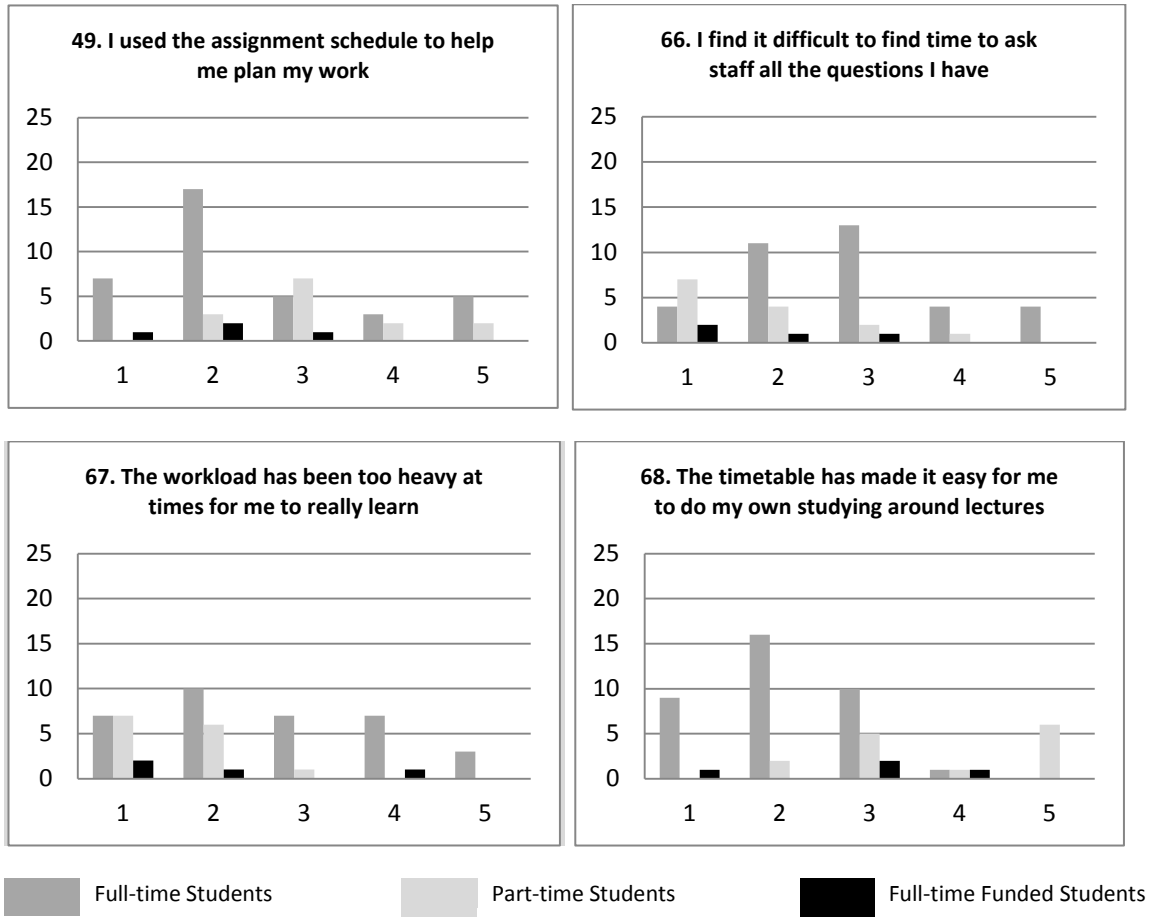

Figure 18: Results from items 49, 66, 67 and 68.

Items 49, 66, 67 and 68 explored workload; the results are presented in Figure 18. Full time and funded students seemed to agree more that they made use of the assignment schedule to help them plan their work (item 49). Both the funded students and the part-time students were more in agreement that they do find it difficult to find time to ask staff questions they have (item 66).

Item 67 showed that part time students agreed that the workload have been too heavy at times for them to really learn, whilst the other students provided a more mixed response.

Similarly in response to item 68, full-time students seemed to mostly agree that the timetable had made it easy for them to study around lectures however part-time students provided a much more mixed response.

These questions highlight the different ways that students have managed their workload and been able to study and ask questions around lectures. These results suggest that there are significant differences for full-time and part-time students and that more investigation is needed to understand the impact of these.

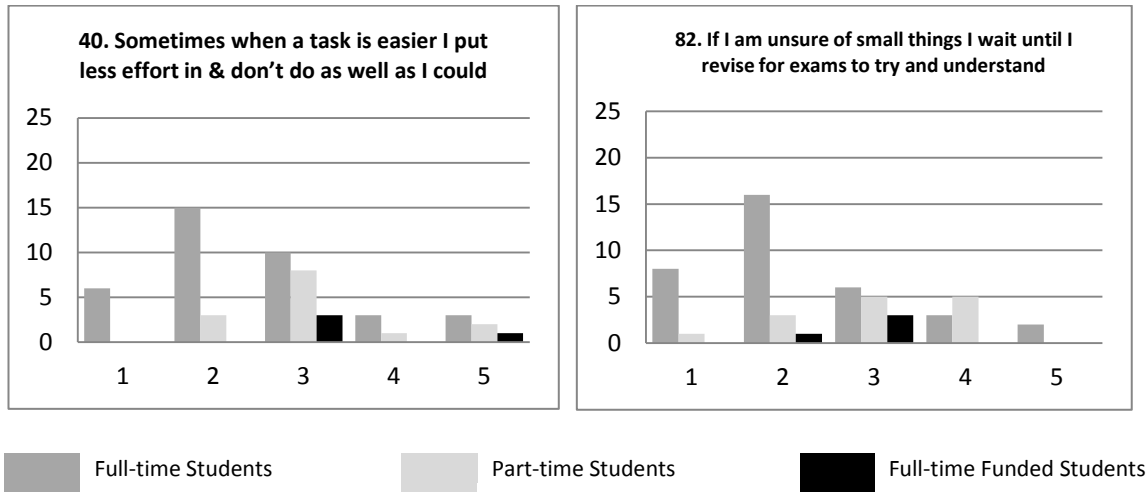

Figure 19: Results from items 40 and 82.

Figure 19 shows the results from items 40 and 82; both demonstrate differences based on 'mode of study'. Item 40 asked students to identify whether they felt that when a task is easier do they put less effort in and don't do as well as they could. None of the part time students agreed with this, funded were more negatively skewed, and full time had a full spread although were slightly more positively skewed. This reflects the qualitative data which showed that comments about this were mostly by full time students. Item 82 again highlights another difference between students as considered by their mode of study. This showed that full time students were more likely to leave small things they were unsure of and wait until exams before they tried to understand them.

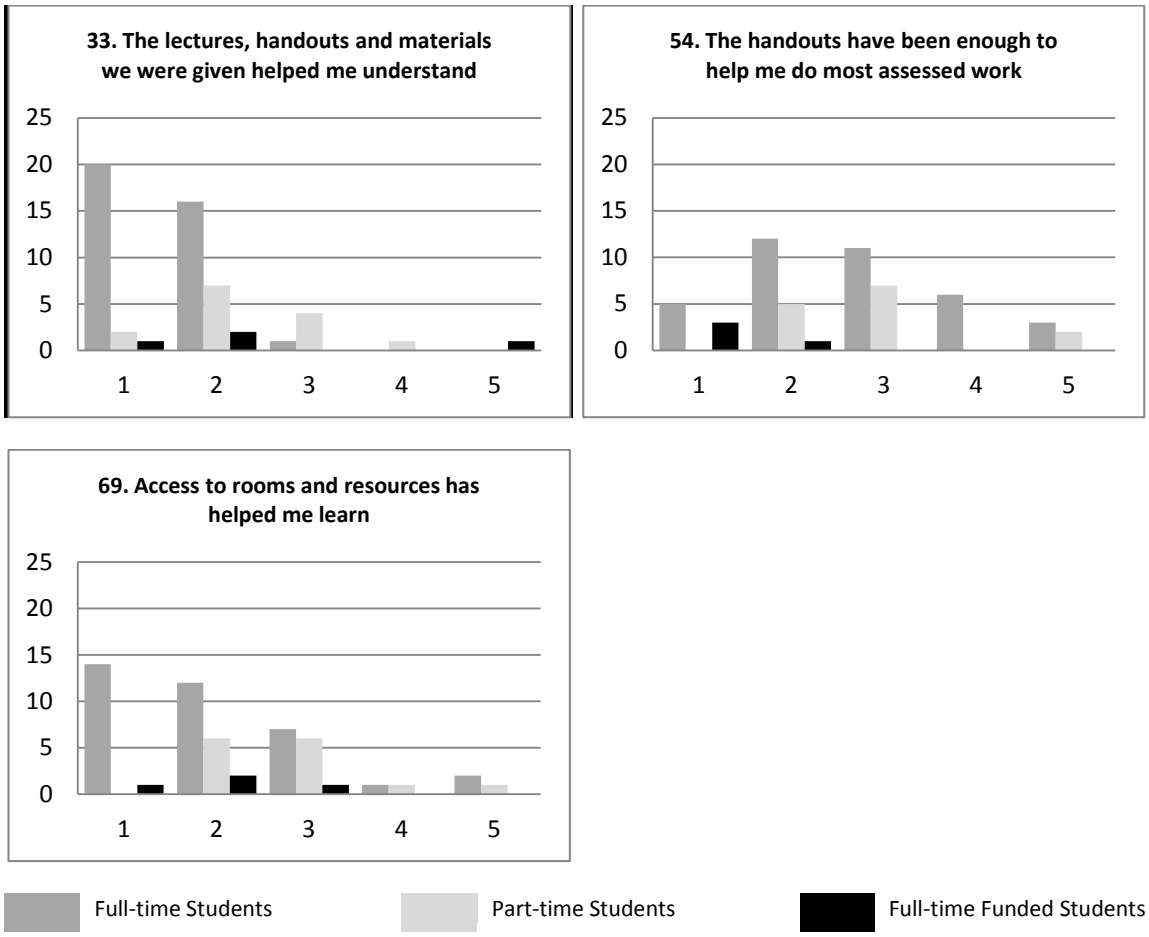

Figure 20: Results from items 33, 54 and 69.

Items 33, 54 and 69 all in some way relate to the availability of resources, the results are demonstrated in Figure 20. In the case of item 33 students were asked whether lectures, handouts and other materials given helped them to understand the subject, and in item 54 students were asked whether handouts had been enough to do assessment work. Item 33 shows a strong tendency towards agreement from the full-time students, and less strong from the other two groups of students, Item 54 shows more students agreeing somewhat or being unsure about when the handouts had been enough for them. Item 69 shows a tendency for the majority of students to agree, however there are some full-time and part-time students who disagreed. The full-time students in the majority agreed that the rooms and resources had helped them learn.

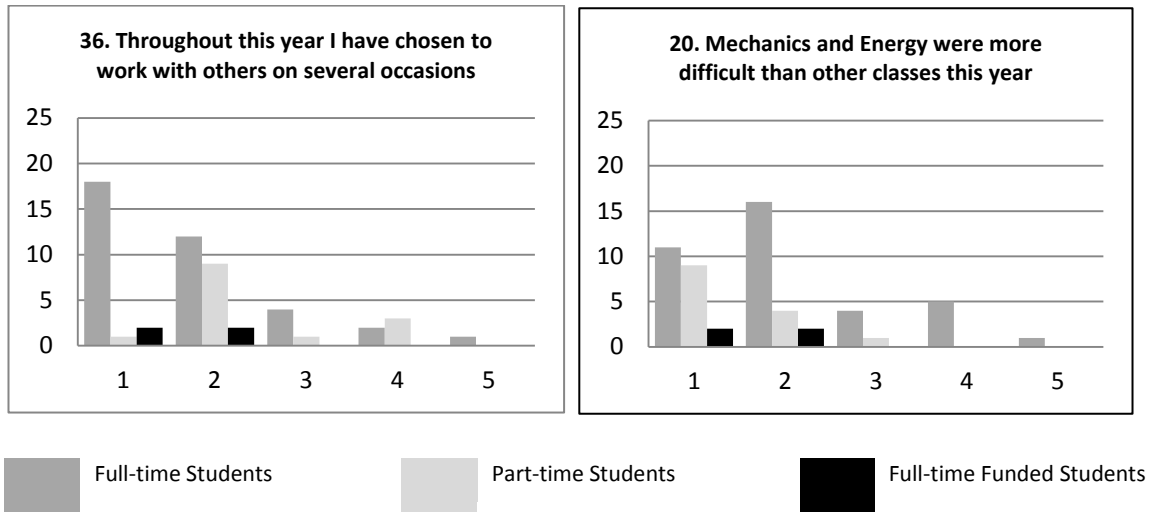

Figure 21: Results from items 36 and 20.

Figure 21 represents results from items 36 and 20. Item 20 explored the notion of whether Mechanics and Energy were more difficult than other subjects. The results show that part-time and full-time funded students agreed, with the full-time students showing a wider spread of responses.

Item 36 explored the nature of peer working asking whether students had worked with others on several occasions throughout the year. The responses by full-time and full-time funded students show a positive skew, with a more varied response by part-time students.

5.10.2 Summary of the KW Tests

The variance tests have shown that with respect to students' mode of study there were several items on the questionnaire which exhibited variance.

When considering the items against mode of study results it can be seen that there are several items where the part time students responded less positively that the other two groups of students. Questions in these cases could be said to be related to expectations. Responses to questions where part-time students responded more negatively were around the notion of how clear they felt learning was, whether students felt that teaching was organised in line with expectations, whether the quality of teaching was what was expected and also whether teaching matched what they were supposed to learn. This may suggest that part-time students have higher or more definite expectations than students with other modes of study.

With respect to resources and more practical aspects of learning again the part-time students' views seemed to differ from the remainder of the cohort. Part time students felt less positive about the way in which handouts helped them to understand a module and also about the way they helped them to complete their work. Part time students also felt that they made less use of the assignment schedule that the other groups of students. Understandably, since most of their time is spent away from campus, part-time students also were less positive about the way that access to rooms and resources has helped them to learn, and also they reported that they had worked with their peers less than the other students had. None of the part time students agreed with the statement that 'Sometimes when a task is easier I put less effort in and don't do as well as I could' which suggests a strong personal focus on achieving.

5.11 Correlation Findings

Correlation tests (Spearman's Rho) were carried out on the data using PASW to look for any evidence of relationships between variables. This was done to indicate 'the strength and direction of the relationship between the variables. In this research, as discussed in the previous chapter, to determine that a relationship is very strong a coefficient higher than '0.7' would be expected, and a coefficient of less that '0.3' would suggest a low or a small relationship between the variables. The range of '0.30-0.49' indicates a moderate to substantial linear relationship, and the range '0.5-0.69' a substantial to very strong linear relationship.

A 90 x 90 matrix was produced to explain all the correlation coefficients for all the items. Of the matrix that was produced there were no correlations over '0.7' therefore correlations over '0.6' were considered in the matrix to signify items with strong linear relationships. There were actually only 3 pairs of items that had a correlation coefficient of above '0.6'. The following three tables demonstrate the strong correlation findings.

		Q3
Q2	Correlation Coefficient	.601**
	Sig. (2-tailed)	.000
	N	56

Table 14: Correlation between items 2 & 3

		Q32
Q23	Correlation Coefficient	.662**
	Sig. (2-tailed)	.000
	N	56

Table 15: Correlation between items 23 and 32

		Q76
Q75	Correlation Coefficient	.621**
	Sig. (2-tailed)	.000
	N	54

Table 16: Correlation between items 75 & 76

Spearman's correlation coefficients over 0.6 and their levels of significance are reported in tables 14, 15 and 16 respectively. With correlations of just above 0.6 item 2 (taken from SETLQ) seems to be an important predictor of how students would answer item 3. Item (2) asked whether students were focused on the opportunities at the university for an active social life and/or sport and it was found to be positively related to the item which asked students whether they hoped their whole experience at university would help make them more independent and self-confident (3) ($r = 0.601$, $p < 0.01$).

The statement which asks students if they felt what they were taught seemed to match what they were supposed to learn (32) was found to be positively related to the item which asked whether students felt it was clear to them what they were was supposed to learn in most subjects (23) ($r = 0.662$, $p < 0.01$).

The item (75) which asked whether students have made a conscious decision about the type of student they are was found to positively relate to the item which asked students if they were more confident in their own ability this year (76) ($r = 0.621$, $p < 0.01$).

Items 75 and 76 have shown a strong correlation, and in addition both individual items also showed significant variance in their responses when analysed against students self-rating of achievement. The correlation pairing between items 32 and 23 reflects and also supports the results shown in the analysis of variance tests which suggests that there is a strong correlation between students understanding of what they were supposed to learn and when they felt teaching match their learning aims, and also a significant relationship to students mode of study.

In the middle 0.4-0.6 range, there were many items that correlated with more than one other item. The large amount of overlap between these items and their correlations makes it very difficult to consider the meaning of the correlation. In addition to the large number of multiple correlations there were also 18 items which did not produce correlation coefficients of above 0.4 with any other items.

5.12 Results Summary

The presentation of the quantitative data at the start of this chapter allowed the overall cohort views to be demonstrated.

The integration of data which was subsequently presented enabled the strength of mixed methods to be shown. The individual student quotes obtained are able to be contextualised and considered alongside the quantitative data to develop an understanding of the main issues influencing perceptions, and affecting practices, of the cohort as a whole.

Chapter 6 goes further to interpret the data and draw conclusions and learning from it to enable the research question to be answered. Chapter 6 takes the data analysis a step further and considered the results in their entirety rather than the assumed (and somewhat arbitrary) themes used to present the data in this chapter.

6. Discussion of Data

6.1 Introduction

Previously the data in this thesis have been presented using the codes assigned to the qualitative data or by the sections presented in the questionnaire. In this chapter both the qualitative and quantitative results are integrated and considered in their totality, providing a holistic interpretation and understanding of the data in response to the research questions.

Considering the qualitative and quantitative results together, without division into themes has allowed for exploration of relationships in the data and for overarching ideas to be explored. The findings which are discussed are principally only valid in the context of this research although some of the findings can be assumed to be worthy for consideration in engineering education outside this context.

It is evident that there is overlap between the perceptions and the practices of these students and that both results are intertwined within the whole context of the teaching and learning experience. These findings support the existing literature of Ramsden (2005) and Biggs (2003) to explain that the practice of learning cannot be neatly separated from the context. Furthermore the findings of this research, considered alongside other studies from within engineering disciplines (Entwistle et al., 2005, Case, 2000, Kember, 1996, Lim et al., 2010, Scheja, 2006) help to form a picture of students' perceptions and practices which may now be considered to be specific (and particularly relevant) to engineering.

This chapter is organised as indicated below:

- Information to support interpretation
- Findings related specifically to the research question:
    - Students' perceptions of their teaching and learning context
    - Students' learning practices, including their approaches to learning
- Implications of the data for practice and further research
- Theoretical Implications
- Methodological findings
- Summary

6.2 Information Informing Interpretation of the Data.

Student motivations and expectations were explored to support interpretation of the data. The achievement of the cohort and of the sample involved in the qualitative study was also considered to further inform conclusions drawn from the data.

6.2.1 The motivation and Orientation of Students

The motivation, or orientation, of students is helpful in understanding what they expect to get out of their experience in higher education and more specifically from their experiences on their programme of study. The quantitative data represents students' motivations and orientations at the end of their second year of study. The research accepts that orientations may change during the course of study and results can only ever, at best, give a snap-shot in time. It can be assumed that in addition to factors related to the course, students' motivations may change for several other reasons such as personal, career opportunities, changes in the job market, after placement experiences etc. At the time of the quantitative data collection the results showed that on the whole these mechanical engineering students had purposeful motivations towards their career and personal academic goals.

The classification of the student cohort as one who are intrinsically motivated with strong career orientations has been kept in mind while interpreting and considering the results further. As Biggs identified individual students may have different motivations (Biggs, 2003) and in this study a range of motivations were evident. Although a large number acknowledged that they were motivated and driven towards achieving a small number of students did express their lack of intrinsic motivation.

6.2.2 The Achievement of the Cohort Involved

The full selection and sampling method used in this study was described in the chapter 4 of this these however some basic data is given here to illustrate the cohort characteristics. To better understand the sample and to consider any additional bias or skew in the results the final cohort marks are considered below.

The average mark for the whole cohort in the year that the main phase of data collection took place was 55 out of 100 (standard deviation 15). Since no personal information was taken from students during the quantitative study it is assumed that this cohort average is representative of the 56 students who opted to be involved in completing the questionnaire. The 14 students who selected to be involved in the research in more depth during the qualitative study achieved a cohort average 64 (Standard deviation 10). These 14 students actually had average grades ranging from 48 up to 83. The breakdown of marks are shown in Tables 17 and 18.

Table 18: Range of marks for the full cohort	
Mark Range	Number of students
0 to 10	1
11 to 20	0
21 to 30	2
31 to 40	8
41 to 50	12
51 to 60	21
61 to 70	18
71 to 80	10
81 to 90	1
91 to 100	0

Table 19: Range of marks for those interviewed	
Mark Range	Number of students
0 to 10	0
11 to 20	0
21 to 30	0
31 to 40	0
41 to 50	1
51 to 60	5
61 to 70	3
71 to 80	4
81 to 90	1
91 to 100	0

Table 17 and 18: Cohort and Qualitative Sample data

Although those who opted to be involved in the qualitative component are shown here to have a higher average than the overall cohort average, the methodology used in this study was selected with an aim of reducing the opportunity for results to be skewed due to the nature of the sampling. As the qualitative results were integrated and not considered on their own the integrated data is assumed to represent the full cohort and not just views of those who achieved a 'slightly better than average' mark.

6.3 Perceptions

As expected from the literature, students' perceptions of the teaching and learning context were found to be one of the key factors in influencing their learning practices. This demonstrated and confirmed that the findings in existing literature hold true within this context; students' perceptions were informing their practices. Students discussed the perceptions they had of the programme, and their experiences on it, with respect to a few main areas, these were: the discipline itself, aims and organisation of the course, impact of assessment, the physical environment, skills of autonomy and self-evaluation, their learning practices and learning aims.

In addition to perceptions which were formed through direct involvement in the context, students' expectations and pre-conceptions were also shown to be influential in determining perceptions of the course.

Whilst perceptions were a feature which students discussed frequently during the qualitative data collection, this discussion chapter acknowledges that there are elements of students' perceptions which would benefit from further exploration. As this study was an initial exploratory investigation into how students perceived their current context, and how they carried out the practice of learning, it did not explore in finite detail the influence or impact of particular perceptions. Instead, elements of perception were identified, as

were aspects of practice, which directly described students' experiences within this teaching and learning environment. Using the exploratory method allowed a number of features to be identified which may be subsequently followed up in research (one way would be to conduct several explanatory studies within the same given context, each focusing on a different aspect of the findings from the exploratory study).

A summary of the key findings related to students' perceptions are listed below (in no particular order). The 'perception data' is discussed in the remainder of section 6.3 and potential action points and/or potential barriers to learning are discussed later in the chapter.

Key findings demonstrating students' perceptions:

- Motivation is affected by marks counting
- Marks are dependent on understanding not tactics
- Learning is not always reflected by marks
- Assessment tasks or methods not always clear
- Some staff are unorganised which affects the effort students put in
- Some pressure is needed to ensure students don't waste time re-doing work
- Sometimes pressure on students' time is too great
- Students are aware of their own strengths and weaknesses
- Students don't need less direction in second year than first
- Most learning outcomes were clear however there were some which were unclear
- Examples and worked problems are needed to ensure learning
- It is difficult to understand without handouts
- Working with peers has helped develop students' understanding
- There are differences in the learning between first and second year
- Staff should behave and teaching a particular ways
- There are occasions when staff are trying to cover too much
- The type of questions students have will depend on when and who they will ask for support
- Some subjects are more difficult than others
- Some subjects are more important than others
- Students do less study for subjects which are less important
- Students look for and want to see relevance in subject material

6.3.1 Discipline Perceptions

The initial outline of what might be considered as forming the teaching and learning context grew from the literature, and was framed directly by the concepts discussed in the qualitative phase. Cashin and Downey (1995) explain that disciplines provide learning contexts that are distinctive in their learning goals and instructional methods. In this study this was demonstrated through the way students had specific pre-conceptions about learning within the discipline such as which subjects are important in mechanical engineering, how engineering students should behave relative to their year of study and also how staff should teach and act.

Students had perceptions about the way others should behave in classes and about the way second year Mechanical Engineering students should behave in general; almost all students felt that the second year requires more self-direction and personal responsibility for learning. Students formed a perception of what they felt first year should teach them, and then also what second year should. The opinions about others and about how learning should take place may be linked to the professional nature of the programme. Students acknowledged that in first year they were happy to help their peers 'get through' and pass the year where as in second year they expected their peers to put in the required effort to do well for themselves and not rely on the support of others in getting them through the year.

Judged by the differences in the interview data there can also be assumed to be different levels of learner maturity/professional identity amongst the students. Some students very much felt that it was up to themselves to search for answers, work through problems and develop their own understanding while there were others who felt they should be given the answers or provided very specific assistance.

6.3.2 Importance and Difficulty

Whilst students identified what they perceived to be 'core' modules, this was not actually reflected in the course design; there were no option modules therefore all modules should be considered as core.

Considering the whole programme structure (appendix E) and the way in which modules are named and numbered (using similar names and numbering structures over academic years), does suggest that some subjects form core streams within the programme. Three modules studied in second year have indication of progression from the first year studies (namely the fundamental theoretical subjects of Energy, Mechanics and Maths). This is identified in appendix E and can be seen through the numerical codes associated with the modules. The other modules do have progression from first year (although it is

possibly not as obvious), with the design and computer modelling moving on from design, with business and manufacture moving on from materials and manufacturing, professional skills moving on from communication, and instrumentation and control moving on in some way from the electrical component included in energy and the environment.

It may also be suggested from the qualitative data that there was a link between what some students considered to be core and what subjects they felt were important (however this was not shown in the Spearman's rho correlation analysis conducted).

The results show that there were aspects of the course which students perceived less important and acknowledged they would put less effort into. Qualitative data showed that there was consistency in the subjects/modules that students were describing as important and in those they felt were difficult; it would therefore be interesting (and potentially a study on its own) to explore this link between difficulty and importance further. It would also be interesting to further explore the notion of importance to investigate how this perception is formed and what affect it has on the practice or approach of students.

Students primarily discussed lack of importance in subjects in relation to lack of personal relevance and with respect to their perception of engineering in general. The notion of 'perceived relevance' (Moore and Exley, 1994, p.17) was referred to by students several times in the qualitative phase. Students acknowledged there were some subjects (such as Business) in which they were unsure of its personal relevance (and to their future careers), with some suggesting that when they found subjects less important they would do less work towards them. The interviews suggested a reason for students not seeing personal relevance in subjects (and therefore not engaging) was linked to previous study students have done; for example if they felt that they already had a good grounding in a particular subject then they did not necessarily see the need to engage.

With regard to the influence of assessment on perception of importance, the programme structure (appendix E) shows the modules considered to be important were ones which all had tests to assess students in the first year, and were subjects with a clear theme continuing into second year.

6.3.3 Worked Examples

Students felt that they should be more responsible in second year for their learning although they didn't necessarily feel like they needed less support from staff than in previous years; this may suggest a lack of autonomy developing in some cases. Students also felt like they needed examples/worked problems to be done in a lesson to

allow them to learn. Furthermore, students felt that they definitely needed seminar sessions to allow them to work through, or have exposure to, problem solving activities; it can be questioned how the need for these impacts on the already full mechanical engineering curriculum. The need for seminars poses difficulty in terms of teaching load for academics and challenges for delivery in cases with large student numbers. A question to also ask is whether the attendance of students at structured seminars replaces or supports students in their independent study activity.

6.3.4 Independent/Autonomous Study

The course structure requires a significant time commitment by students which may no longer be realistic in current climates where a large number of students need to work alongside studying.

In this programme students are issued with an assignment schedule at the start of each year. Whilst staff assume that an assignment schedule is used by students to help them better manage and plan their time it may also lead students to assume that there is no other work expected to be done outside of the scheduled assessment tasks (linked to students quoting they only do '*anything that's marked')*. Academics need to be aware of what implicit messages they portray to students, for example, does the provision of handouts, supportive documents on the e-learning platform and working through problems in the class give students the message that staff will provide all learning to students?

The existence of the constructs shown by Bloom (as cited in Osborn and Nag, 2002*)* and any associated students' progression along them can only be inferred from the data gathered in this study. With respect to their independent study students' freely discussed several of the skills reported in the lower level of Blooms taxonomy however as the questioning didn't go into the detail of specific assignments there was little opportunity to explore the higher level skills. Further examples of lower level skills were given in that students discussed liking to learn in small steps, completing questions and using examples, working with peers and asking staff for support when needed.

In preparing for a modern society which requires learners to adapt to frequent change there is a need for students to develop autonomous approaches to learn new forms of knowledge (Boud, 1988). The data (both qual and quan) show that students placed value on handouts and did not perceive they would need to do additional reading or learning for assessments (since the handouts they had been provided with were enough) is a significant finding for this context and also for engineering education generally. It is possible that this practice does not show students developing autonomous approaches to their learning. There is a need for engineering lecturing staff to understand how to

encourage autonomy and also more broadly what messages they give students (e.g. those which implicitly or explicitly discourage autonomy).

Considering student autonomy with respect to their learning and in the terms described by Boud (1988, p.17) suggests that for students to be effective they should make 'decisions for themselves about what they should be learning and how they should be learning it.' Boud advises that teachers cannot direct all aspects of the learning process. Messages are given to students throughout the different aspects of their student experience; in particular this research has shown that students perceived messages related to the importance of assessed tasks, demands of a module, relevance of a module, demands and expectations about their use of time.

6.3.5 Student Expectations; Opinions of Quality

The programme of study aims to produce graduates in Mechanical Engineering who have the skills and attributes to enable them to take on Professional roles and work towards becoming recognised as Chartered Engineers.

Sander et al. (2000, p.310) suggests that 'addressing expectations can produce measurable improvements in student outcomes' and that 'expectations and preferences of students' should be collected and considered as valuable data. This research has identified that students have expectations about how staff should behave and that these expectations affect the attention and effort students put into their learning.

Students' expectation of staff were prominent in both rounds of interviews with students judging interactions with staff based on their expectations about how teaching should be organised, how support should be offered and how professional staff should be. Examples of non-engaging teaching were when students felt that staff would '*just read PowerPoint's'* so that students felt their time could be better spent elsewhere. There were times when students were unclear about what they could learn; this would be an interesting area to explore further. Within this study the reasons for students being unclear with respect to learning potential were not explored explicitly but could be assumed to be linked to several points from the data such as; poor or unhelpful lecturing, overfull curriculum, unclear learning outcomes etc.

It is students' perceptions of the teaching and assessment procedures, rather than the methods themselves, that most directly affect student learning (Entwistle et al., 2002). This was reflected in the quantitative data where almost 95% of students acknowledged that they put more effort in to subjects that seemed to be organised well (mode of 2). There is therefore a call to understand what aspects students' perceive to be key in terms of good organisation. The suggestion is made that effort should be put into

understanding, through dialogue, students' expectation and perception of teaching, based on the fact that their prior experiences maybe very different to those of their teachers.

Some students made attendance decisions based on timetabling (e.g. where students might then have 4 hours off between sessions) and also based on their perception of the value or importance of the subject. With respect to value this was often judged on how useful students felt the teaching in the sessions was; students gave examples of this related to what they considered to be engaging and also non-engaging teaching.

Consideration needs to be given as to whether the format and methods of delivery within engineering are still appropriate. School curriculum changes, as do accepted teaching methods, and maybe more significantly, the routes of students getting to university have become more wide and varied. Academics need to explore whether the methods and techniques which helped them learn are the same as those which will help the students of today learn. In the same manner the development of staff needs also to be considered; if it is decided that teaching methods and curriculum content does need to change then consideration is needed as to whether staff are prepared or equipped to execute the changes.

Ramsden (1987) in Jones et al. (1997) explain that some students entering higher education believe that their 'lecturer has all of the knowledge...' In the qualitative data students demonstrated that the level of support they expected seemed to differ; some students were willing to see beyond the immediate actions of a member of staff and consider the actions in relation to their own learning. Most participants did appear to be taking the responsibility for their own learning further; with two thirds in the quantitative study ensuring that they do their own study if they feel teaching of a subject has not been ideal.

6.3.6 Student Expectations; Professionalism

Lecturers at Universities are 'often involved in preparing students for the demands of professional life' (Macfarlane, 2004, p.7). This programme aims to be challenging and also relevant, informed by research, consultancy and professional experience. Students appeared to take this on board and felt that staff should act professionally in order to teach on a programme which is to prepare them to become professional engineers. Dress, time keeping and organisation were three of the factors that students discussed in terms of professionalism of lecturing staff. Students wanted, and expected, an experience which presented them with what they considered to be high quality

professional teaching and responded well in situations in which they perceived this to be the case. Horlick et al. (2009) has suggested that medical schools have had to address the fact that 'students embarking on careers in medicine are idealistic' but that the students do have 'a vague understanding of the values and characteristics that define medical professionalism.' Horlick et al. suggests that traditionally these 'skills and values of professionalism have been portrayed to medical students through role models and also in lectures and seminars' as expected by engineering students in this study.

Students can benefit from developing an identity with a programme or a profession during their studies. Through students' construction of their professional identities they 'learn to situate their own knowledge, interests, and sense of self within the larger context of professional engineering' (Eliot et al., 2008, p.1). Construction of a professional identity can be a powerful influence upon student retention in engineering programmes, their learning and subsequent adjustment to the workplace. The questionnaire presented data which showed the strong career orientation of the cohort involved in the study. The fact that these students are career orientated may also be an influential factor in why these students expect a level of professionalism amongst the teaching staff they interact with at the university. Students identified lack of professionalism as a negative or unhelpful facet of some interactions with staff. This study suggests that if professionalism is to be considered by this cohort to be a characteristic of good practice, then it should be exhibited by staff.

6.3.7 Self-evaluation

While students are evaluating their teaching and learning (based on their perceptions) it is also appropriate to explore students' perceptions of themselves. Students had perceptions of their own strengths and weaknesses and felt that their strengths and weaknesses were the same as they were when they started the course. Whilst it is difficult to say how correct these perceptions are it is proposed that this should be an area which is addressed during engineering education; to enable students to be able to self-reflect and self-evaluate in an informed manner.

6.3.8 Clarity, Value and Effort in Assessments

As an appreciatively large influence on the learning context, assessment was discussed in detail by students during their interviews.

The different modules students participate in, and the different assessment tasks they are required to carry out, can be seen to require different levels of engagement from students. The tasks can be completed with different types of learning, for example, some tasks can be considered to really require deep learning, others are possible to be

completed with a methodical surface-type approach. Lack of clarity in assessment was discussed in the literature and students did discuss times when they felt that they were unsure of aims and expectations of assessed tasks. Assessment culture should involve students as 'active and informed participants' and assessment tasks should be authentic, meaningful, engaging and mirror realistic contexts (Sambell et al., 1997, p.352). Students demonstrated that they agreed with this, feeling that they didn't like the multiple choice test they had as it was '*a bit pointless.'*

Students explained that they don't always feel that marks they receive reflect the effort they put in, and the learning that they personally feel they have achieved. For example, students may be asked to complete a procedural task which requires a lot of background reading for them to fully understand. A standard assessment would generally mark the procedural aspect of the task without exploring whether students developed a conceptual understanding of the underpinning theory. In cases such as this a small procedural error may result in marks being lost however credit may not be given for the fact that students developed an understanding they previously did not have. Alternatively students may complete the procedure correctly by following an example, and without making any effort to truly understand, in this case they may not have deeply learned but may still receive full marks.

In the interviews it was clear that some students found it difficult to judge their own progress during the year. This links well with the previous point of self-evaluation, that engineering education may need to better equip students with skills of self-reflection and evaluation. As a result of the assessment tasks only about half of the cohort perceived that most feedback had been beneficial in moving their learning forward, there are multiple reasons for this suggested in the data including some students seeming to forget or not recognise that they had been given feedback.

Towards the end of the academic year students involved in this study recognised the benefit that assignments had to their learning, this seemed to contradict an earlier view that assignments would not be as beneficial as class tests.

Students in this study did say that the fact that their second year marks could count towards their final grade was affecting the amount of effort they put into their studies. Students reportedly felt less motivated to do well in first year as the year doesn't count towards their final grade. In recent years the admissions tariffs have been increased to position the university more closely in-line with local universities and other comparable universities. Due to the nature of the accredited programme the admission requirements are such that standard entry students must have qualifications in Maths and Science. The admission tariff has changed during the time of this research, going up from 260

UCAS points in 2009, compared to 320 in 2012. Students are only required to achieve a mark of 40% in assessment of modules for progression to the subsequent academic year; it is suggested that a pass grade of only 40% suggests there could be up to 60% of the curriculum which students have difficulty with (although as this data has shown some students felt they did go on to learn more during the summer break after their assessments).

6.3.9 Workspaces and Resources

Students perceived that their comfort in lectures affected how much attention they would pay in classes. One of the factors most commonly discussed with respect to comfort was the space within the lecture rooms, with the issue being that, particularly at the start of the academic year, some rooms didn't have enough seating. The questionnaire element asked students about comfort which more broadly could also cover issues such as an ability to see boards clearly, temperature, sound levels etc. Although issues did exist within lecture rooms students overall felt the access they had to rooms and resources at the university supported them in their learning.

6.4 Practices

It is recognised that understanding how students approach their studies doesn't necessarily help engineering educators in a practical way; it doesn't tell staff how students are responding to particular aspects of the teaching and learning context or how they are responding to specific tasks. Looking more at students practices such as 'what students do and why they do it' may be more likely to help in course design and in improving student satisfaction. In this section 'approach' is considered to be a sub-set of 'practice', that it, the way a student approaches a learning activity is assumed to make up part of the general learning practice.

Looking at student practices has allowed features which support or prevent learning within this context to be determined. This can be used to inform strategies within teaching which would encourage appropriate learning practices and address the action or discussion points for learning (shown indented throughout section 6.4). In this study the aim was not to develop the strategies as such, it was an exploratory study to begin the investigation and conversation into/around the learning practices of mechanical engineering students. The findings have suggested that the programme team need greater dialogue with students to understand their practices rather than making assumptions about what students are doing, especially as the assumptions would be based on staff perceptions rather than student perceptions of the context.

The remainder of section 6.4 details the practices which were described by student and inferred from the data collected. The bullet points below summarise the aspects of students' practices which are discussed.

Key findings demonstrating students' practices:

- Students put more time into independent study for some subjects
- More effort is put into well organised subjects
- More particular about attending some classes than others
- Difficult to maintain constant motivation during the year
- Reflecting (when there was space to do so) supported learning
- Assignment schedule used to help plan work
- Less effort goes into easier tasks
- Work during the year is predominantly on assessed tasks
- Worked with others on more than one occasion
- Methods of peer working varied
- Students seek peer support in the classroom
- Working with peer is not uncommon in assignment preparation
- Students have taken deeper, organized approaches throughout their studies than surface approaches.
- Students do take a surface approach to carrying out tasks; using formula to solve problems without understanding theory.
- Students leave some learning until revision time.
- Learning during the year is focussed on assessment tasks
- Preparation for some exams is tactical
- Students are often active in classes in some way

6.4.1 Supporting and Developing Understanding

Students recognised that they made conscious decisions about the type of student they were i.e. they had particular ways of going about the practice of being a student. This may suggest that students consider what actions are required for them to 'do well' and achieve what they consider to be success. What cannot be assumed from the data is that students all decide to be 'good' students in the same way that academics might expect, for example, they may decide that they want to 'just pass' the course, they may also decide that they want to get a first class degree. Benchmarks will be different for each individual but what is important is that 75% students felt they have made some decision about the actions they take as a student. The fact that the course is accredited and recognised by a professional body may influence some students in wanting to do well and be in control of the type of outcome they may obtain.

There is evidence that as a group these students are active in their learning and throughout their studies have taken deeper and more organised approaches. Students in this study adopted learning strategies, of which interaction with peers was one example. Other examples of strategies included actions which appear to have been planned and others which seemed to be more reactionary including: solving tutorial problems, planning on attending all sessions, seeking help when unsure, leaving learning until revision time and putting more effort into difficult tasks. Whilst it is a positive finding to note that students are active in their learning it is interesting that students identified that they do take surface approaches to carrying out some tasks and to using formula to solve problems.

There were examples of teaching which students felt did encourage a deep approach such as when students found it helpful that staff wouldn't just give them the answer, requiring students to continue working until they really understood the issue. Students indicated in the interviews that they want to understand the reasons behind things and fully understand subject areas and in the questionnaire students identified that they like to understand how topics of study relate to practice. There were also contradictions to this, with some students expecting answers to be given to them by staff rather than being referred to look in books.

The examples students gave in this study showed that there were several occasions when students wanted, and were aiming for, conceptual knowledge and understanding however this seemed to be second to students obtaining a procedural knowledge or ability. Students discussed knowledge with respect to knowing how to, and being able to, solve problems. They discussed understanding in terms of wanting to understand the theory behind formula.

6.4.2 Organisation of Assessments

Students agreed that they had made use of the assignment schedule to help them plan their work. This agrees with the finding that students are organised with their study. Students also identified that they only really worked on assessed work during the year. Although the assignment schedule is intended to ensure work is spaced out students did report that they spent the majority of their independent study time working on assignments. An assumption is made regarding the number of hours a student will spend on a module based on the number of credits, for example, a 10 credit module is assumed to be 100 hours and a 20 credit module is assumed to be 200 hours. These hours include contact time at the university and also any independent study. Five out of the seven modules studied provide opportunities for accumulation of marks during the course of the module therefore have an element of assessed work during the year.

In the interviews one student acknowledged that they put less effort into one of the assessment tasks that they felt was easier; this can be understood as an example of students' perception of a task affecting their practice. Most students discussed that there were some subjects which dominated their study time. It was inferred from the qualitative comments that students were actually spending *significantly* more time on one subject than others. Students explained that they put more effort into subjects that they felt were organised well, which (from the qualitative data collection) included teaching directly but also timetabling of sessions, quality of handouts, reference and link to reading material and also the timekeeping and staff appearance/presentation of themselves.

6.4.3 Loaded Curricula and Equality between Subjects

The academics at the host institution operate an 'open-door' policy, advising students that they can 'drop-in' on staff or make appointments if they want to be sure someone will be available when needed. Despite this, some students identified that in practice they did have difficulty asking all the questions they had. Candy (1988) suggests that when students do actually do need assistance is does not necessarily represent an inadequacy on the part of the student, rather it may be an example of a higher form of autonomy where the student can choose when to work independently or when to seek support.

Students also discussed assessment frequency and demand (covering both difficulty and time) which in turn affected their study patterns. Students explained that they did not spend an equal amount of time on all subjects. They also identified that they found it difficult to maintain a constant motivation towards work during the year. Motivation was not defined explicitly in the questionnaire however it was used as an umbrella term to cover aspects considered in the interviews about student effort and the time they spent on study during the year.

The demands of the programme seem to cause difficulty for students with modules fighting individually for their time and effort. Overall, students felt that there was too much content trying to be covered by staff. There appears to be little space for encouraging transference of student learning between modules or blending of learning since each module individually is so full. Due to the modular structure it appears that there is also little opportunity to discuss with students expectations of the programme in general and instead students tend to get 'inducted' into modules and a particular academics' way of doing things. Within sessions there is little opportunity made for dialogue or discussion about expectations; expectations of students may be discussed at the start of a lecture (from observation during pilot study) or maybe as an assignment is given out however they are not often referred too again during the course of the year.

The modular structure of this course therefore adds difficulty when trying to manage the whole student experience. The programme team need to consider whether the current modular structure allows students to form a coherent view of the programme they are on? When considering dialogue and consistency in the messages students receive about their programme the team also have to consider the need for dialogue between themselves. How can students be expected to transfer and connect their learning if academics don't work together to provide a coherent learning environment for the students?

Students admit that they will prepare tactically for some exams and that there is, at least, one subject that they just aim to pass. Students also identified that they wouldn't necessarily worry about small things they were unsure of until nearer the exam time when they covered the subject again during revision. Questions arising are; was there not time to learn all aspects of the curriculum properly, are some subjects less important to the individual, are some subjects seen to be less important in engineering, are there some subjects that are more difficult that others, and are the exams students will be tactical about the same as the ones they just aim to pass? This approach to learning may suggest that there is not necessarily a culture of always attempting to take a deep approach and that student are selective about which things they allow to 'slip past' without fully understanding. It is interesting to questions why, and if students should, use exam preparation as a time when they plan to try and understand things? Do students expect things to 'come together' when they look at the subject as a whole during revision time or do they maybe only try to learn when they feel they 'need' to for exams?

How do staff in this context, and academics in general, consider the way students perceive the curriculum, and how do they ensure the key features of a curriculum are perceived as such by students? More fundamentally both within and outside the specific context is the question which much be considered; is it right that students should allow some things to pass them by during the year or would academics hope they would be aiming to learn all aspects of the curriculum during the year rather than at the end, and if so, how can this be encouraged?

6.4.4 Peer Working

As previously identified 'interaction with peers' is one example of a learning strategy students made use of. Boud (1981, p.14) acknowledges the strength of peer learning and in this study it was clear that students also recognised the value of peer working resulting in a large number of students engaging in it during the year. The data obtained during this research has provided new knowledge about the nature of peer working within the context, and adds to the body of literature regarding informal peer working.

Students reported that they saw value in the practice of working with peers and they felt it helped develop their own understanding. Vines (2010, p.1) clarifies that '...informal peer group activities have always been common in academia and often fill a great deal of students' time...' Students in this study have been shown to be making use of peer learning in different ways, at different times, during the year. Students worked with peers to check understanding or procedures in class, to develop understanding outside of classes and to complete (or dissect elements of) assessment tasks.

Most literature discusses peer learning with respect to those peer learning activities which are structured or organised as part of the teaching. Vines (2010, p.1) agrees that 'student-initiated peer learning activities outside of the context of explicit instruction is a fairly overlooked source in educational research' this is 'in stark contrast to a vast body of literature on peer mediated learning in classrooms and other instructional settings.' Vines (2010) uses the term 'informal peer colloquia (IPC)' to describe 'encounters of a few near-peers who gather on a voluntary basis to elaborate on subject-related matters'. From the perspective of a social theory of learning IPC can be viewed as communities of practice that 'lie out with the formal curriculum and complement it' (Knight, 2002, p.275). From the qualitative examples within this mechanical engineering context it can be considered that several students where engaged in what Vines terms as informal peer colloquia, where students gathered on a voluntary, but fairly regular, basis to discuss and work on discipline specific material.

In lectures, students would ask peers for support before asking questions to staff which may indicate a pragmatic approach, showing students use whatever questioning method they feel is needed to address their own problems or questions. Students decide in the lectures which aspects of the content are important, this then defines when they will ask questions to members of staff. Several students identified that they would only ask questions when they felt there was something fundamental that they didn't understand, whilst the questionnaire showed the cohort in general did not see it a problem to take up time in lectures asking questions.

Boud (1988, p.29) clarifies that autonomous approaches do not suggest learners work in isolation to one another; rather they become 'interdependent learners, working with and helping each other.' With respect to assessments some students acknowledged in the interviews that they did discuss assignments in peer groups first and then go on to solve them individually.

Students acknowledged that they worked with others on more than one occasion, they tended to work with others at a similar level and that they felt some of the peer working groups became more elitist as the year progressed. The qualitative data suggested that

students became more likely to protect themselves as the academic year progressed rather than in the first year where they wanted to help each other to *get through* the year.

There were students in the interviews who explained that they very rarely engaged in any informal peer work, however within the learning context, all students have some degree of organised group work or working with peers (such as in lab groups). Often these types of activity may require students to use different skills to those they would use during informal peer collaboration; in lab classes students are following set instructions to carry out a task as a group rather than working together and drawing on each other's understanding to solve a problems.

6.5 Implications of the Data for Practice and Future Research

Sections 6.3 and 6.4 have presented a discussion of the data. In section 6.5 discussion points have been considered and questions for engineering educators are posed alongside the suggestion of additional areas of research.

6.5.1 Need for Dialogue regarding Discipline and Higher Education Perceptions

It would be interesting to explore further where the student perception of how they (and their peers) should behave, and what they feel is to be gained at different stages of the programme, has arisen from; whether these were perceptions students had of HE before commencing study, whether they were ever discussed explicitly by a member of staff, or if the students have inferred these from an aspect of the courses structure. It would be interesting to explore further whether other engineering students have similar perceptions and whether they actually match the expectations and intentions of staff.

6.5.2 Expectations: Staff Professionalism and Quality Teaching

Students in this context appear to have clear expectations about how they feel teaching should be done. This suggests that academics would benefit from discussing these expectations with students, engaging in dialogue about them, and explaining why things might not be done as per the student expectations - this might allow for better alignment between expectations and actual perceptions. There are some examples of how students' expectation could be better managed, such as with respect to how much support students can expect from a member of staff. If this was discussed from the outset students could better understand why there are occasions where staff might turn them away, for example, directing them to some independent study to ensure students learn and understand for themselves.

An implication for course design which arose from the data was the acknowledgment that there were issues of quality which influenced students' choices around which sessions to

attend and which could be missed. The need for pedagogic awareness by staff is clear through students' expectations of professionalism and also student attendance decisions being based on their perception of academic value (i.e. useful, engaging etc). Staff require an awareness of good pedagogy to support students in making the most of the learning situations available to them.

A noteworthy aspect which emerged from the data collection was the student view of staff professionalism. This was not explicitly explored since it had not been expected from the initial literature to be discussed by students as an independent entity. Before data collection took place it had been assumed that relationships and interactions with staff would influence students, the professionalism of staff however had not been identified from the literature as a key feature which might influence the relationships (and therefore the perceptions) themselves. In this context the students interviewed had fairly prominent expectations about how professional the staff should be. This aspect of the data deserves further consideration for example; is this notion of professionalism specific to this context, is it naturally driven by the professional nature of an accredited academic course, is this something relevant to all aspects of engineering i.e. a facet of the 'inner logic of the subject', or this expectation of professionalism true for all students in Higher Education? Students appeared to expect that they should be in a professional environment with similar standards as their future places of work, in order to prepare them for their future careers. Further exploration of what students view to be 'professional' traits or actions would be useful to explore in this context how academics can achieve the correct balance between professionalism and approachability, and also how professionalism can be exhibited by staff in such a way that their own individual academic styles are not forced to change. There is also potential, although not explored in this study, that this could also be related to the more recent notion of students acting as customers within higher education environments and expecting a certain level of service.

6.5.3 Importance and Equality of Modules

Students explained that there were some subjects which dominated their study time. In the context of this study it can be observed that the structure of the course (with 10 and 20 credit modules and notional study hours) quite rigidly sets expectations on students with respect to workload and study hours. Staff in this context should consider whether they are comfortable that students do not value and treat subjects in the same way; that they do not spend equal time on all 20 credit modules. A wider pedagogic issue is whether academia expects students to study equally for all modules of the same size, or whether it accepts that students will always have their own interests and that there will be other factors which influence how much time they spend on subjects. As a cohort,

students agreed that during the year their workload had been too heavy at times for them to really learn. A large number of students identified that they only worked on assessed work during the year; this suggested that a further exploration of the expectations held of students' independent study could be useful, for example, are these expectations appropriate and are they communicated with students?

The notion of 'important modules' should be questioned further; do staff want to encourage a view of core subjects or do they want to work to discourage this so that all subjects are viewed more equally. Further study should also include an exploration of what messages are implied through course structure, for example; how should courses be structured to ensure appropriate messages are given out, what affect does the repeating nature of some subjects have on students, how do students respond to the obvious progression of some subjects and how the does scheduling of subject and assessment methods affect the perceived importance of subjects. It would be interesting to explore whether views of relevance with respect to engineering professions are formed before study on the course or whether some aspects of the course influenced them. This notion of perceived relevance within the curriculum should be addressed; possibly through ensuring aims and outcomes are made clear to students so that they see the relevance of all subjects and are aware of the opportunities to progress within them.

As students recognised that their motivation did drop during the year it would be interesting to explore this further within this context; when did motivation drop, was there a link to assessment tasks and did approaches to learning change at these times? Further exploration would also be interesting to explore what factors other than 'fear of failing' motivated the students in this context; initial analysis of the qualitative data suggests issues such as marks, current or potential careers, peers and prior experiences could also be related.

6.5.4 Issues Affecting Autonomy

As it has been shown, the students in this context had a strong feeling that they did not, or could not, learn in lessons where there were no example problems covered. Based in a context where several of the assessments rely on students to be able to solve problems it could be assumed that the nature of the assessments prompt the students to expect, or rely on having, experience of example problems. With the expectation of having worked examples being so strong it could be questioned whether within this context this influenced students perceptions of the individual modules, and whether a module without worked examples was seen in a different light to one with several examples. A question arising is whether the need for examples is an engineering

specific finding (is this how engineers in general feel they learn best) and/or is it driven by the types of assessments used? Whilst acknowledging that learning from examples is useful there is also a suggestion linked to Bowden and Marton's variation theory that students may be limited in the future by the types of problem they have had exposure too, and they may lack skills to solve any different, or more complex, problems (Bowden and Marton, 1998).

The value placed on handouts by these students should be further questioned; in this context evidence suggests that they are related to the overall experience of the teaching, and to the evaluation of the teacher. Can it be considered a negative facet of the teaching experience that students felt they could not determine key points in their learning without handouts explicitly helping to identify them? Further investigation of the nature of handouts would be useful; what do students hope to gain from handouts, what makes handouts helpful and what affect does it have when staff do not give out handouts? Through provision of handouts, and/or electronic class notes, do staff discourage students to from reading more widely around the subjects within the curriculum? Additionally, what do staff intend the role of handouts as being, if they do not include all learning material then are students aware of the need to carry out their own additional learning?

Some students acknowledged that they did not feel as though they need to put extra work into their learning because they were taught everything they needed to know in the class. A question for the academics in this setting is whether this really is the case; do they really cover all aspects within the classes or are there elements which students must focus on themselves? If academics do portray that they cover all aspects of the curriculum then is the reading students will do limited as a result, therefore potentially discouraging a wider reading of engineering in general. More generally the question is raised; is the role of an academic to cover all aspects of the learning, or should they always be encouraging academic skills, and further learning, in students. If it is assumed that academics do not intend to cover all of the learning then how can they ensure that students understand this?

Students' indicated in this study that they were aware to some extent of their own strengths and weaknesses, this could be further developed by encouraging students to explore more through the use of personal critical evaluation skills, skills of self reflection and use of tools such as the Effective Lifelong Learning Inventory (Deakin-Crick et al., 2004). Students indicated that they felt the strengths they had in previous years had continued, a pedagogic questions arising is should engineering education be looking at developing well-rounded students who grow strong in several areas or should it be encouraging students to focus on, and improve, existing strengths. A tool such as ELLI

would show personal strengths and weaknesses and offer students the opportunity to consider their weaknesses.

6.5.5 Assessments: Clarity, Value, Organisation and Marks

In this context staff and student dialogue could go some way to correcting the lack of clarity students felt, as could, more well-defined written briefs. Further exploration would be interesting to explore how students' effort and approach changed in the situations where they faced lack of clarity. This feeds into existing pedagogic discussion about how much guidance students should be given and how prescriptive tasks should be, and how beneficial it can be for students to work with some degree of uncertainty? Further to this study, exploration of the assessment influence could take place within this context to see what aspects of the assessment are most influential, for example the introduction of more assignments in the second year or the fact that the marks from the year can count towards the final award.

It is already widely reported in the literature that assessment influences learning however in this particular context students identified that their study patterns were affected by the frequency of assessments and the relative demands of the tasks. In this context it is suggested that academics and management have some outstanding questions which should be addressed with respect to assignments; is there more needed in organising the assessments than just a simple 'assessment schedule'? Whilst the management set the maximum number of assessments for a module it is suggested that there should be more consideration of the consistency between assessments e.g. the equality between assignments, relative difficulty, relevance to students, hours of study required etc. There may also be an opportunity to make more use of the AfL principles in this context; allowing for opportunities for draft submissions or peer review to provide feed-forward to students so that they have some guidance on their work before the final deadline.

Debates are already taking place within Higher Education which discuss the purpose and role of assessment (e.g. Boud and Falchikov, 2007). The suggestion from students in this thesis that learning is not always reflected by their marks reflects a specific aspect of this debate. Engineering educators may need to consider what marks are awarded for, and whether students are always aware of this. From this finding it could be suggested that more dialogue with students may be needed to discuss what students feel they may have learned and techniques such as 'think aloud protocols' could be used in assessment to explore concepts. Tasks which require students to reflect on their learning may also be useful in this type of situation. It would be interesting to explore how this perception the learning is not reflected by marks affects students' approach, and effort, in their subsequent pieces of work.

One reason for a delayed recognition in value of assignments may be that students are more used to having exams (and the feedback from them to highlight their immediate weaknesses) and in this context the rationale for the assignments, and what students might learn from them, is not known to have been explained. This is an area itself which warrants further exploration to ensure feedback is perceived to be useful for students. A question resulting from students reportedly being more motivated in their second year assessment tasks is what impact this has on their first year learning; does it mean that students move onto second year less prepared than they could be? A lot of modules in second year build upon first year knowledge and understanding. Do the programme team need to ensure that first year receives the same level of effort as second year so that students are not disadvantaged in subsequent years if they did not see the 'value' in putting effort into previous years of study which did not 'count' towards a final grade?

6.5.6 Supporting Understanding

One of the findings relevant for this context, and potentially beyond, is that students indicated that they do want to understand the reasons behind things and they would like fully understand subject areas. In the questionnaire the cohort agreed that they like to understand how topics of study relate to practice - the question for academics in this context, and for academia in general, is how to encourage this? In a context where there is already a heavily loaded curriculum how do the programme team ensure they provide students with the opportunity to learn more widely about subjects rather than just focusing on the narrow segments of the curriculum which are assessed? Students' qualitative comments can offer some suggestions, such as encouraging students' interest in understanding how formulae is derived and making the context of the formulae relevant so students can apply theories and formulae in an informed manner. The suggestion is made that academics should take on board the notion of constructive alignment and encourage opportunities where students need to understand theory and build upon their understanding rather than situations where students maybe only need to apply formula to pass a stage on their course.

An addition question which arises from student comments is; are those that need it given the time to really learn something (e.g. time on their own or space provided within the curriculum). Questions can be posed about the way that the timetable is set up and whether it does in fact support students and provide adequate learning opportunities for them? A general question to ask both within this context and beyond is, if curricula are packed and expect students to complete 40 hours study a week then where is the time for students to reflect on their own learning? Do the constant stream of assessments and the overly crowded curriculum prevent students from reflecting and really learning material?

6.5.7 Approaches to Learning

Whilst deep approaches to learning are considered to support students in achieving higher quality learning outcomes it can be argued that many of the situations engineering students encounter during a programme of study don't necessarily require students to have achieved a deep level of conceptual understanding to be able to engage with the task or activity. The concept of procedural and conceptual knowledge/understanding is helpful when considering learning for engineers as it initiates the question of what is actually wanted from an engineering degree. Whilst curriculum and assessment tends to focus on the practical and the procedural ability of students to solve pre-defined problems, academics expect they understand the theory and concepts which underpin the problems they solve.

The suggestion that there are different types of knowledge in engineering can be related to the wider aspects of teaching and assessing engineering, and it can be questioned whether academia should acknowledge this distinction more. It may be that in the engineering workplace and academia it is right that different learning (conceptual or procedural) may be needed in different situations e.g. for different modules or with respect to different assessment tasks.

It would be interesting to explore the contradiction between some students wanting to understand but also some wanting the answer. Why do some students feel they should be given the answer straight away and what aspect of being referred to a book do they feel hinders them? This may be linked to the level of skill students have in the field in question; students with a higher level of mastery in a subject or those with deeper learning tendencies may be less likely to expect to be given the answer than those who could be considered to be more of a novice in the subject.

There are also questions to ask based on students' decisions about the 'type of student' they are, such as; what influenced their decision, when did the decision take place and did it alter during the course of study?

6.5.8 Peer Learning

The role of peer working is an interesting and valid consideration with respect to assessment preparation and completion; students acknowledged that would revise together or do preliminary work for assignments with peers. In the context of this study it can be questioned whether staff should be informed of when this peer working has taken place to avoid any risks of plagiarism? This thesis suggests that there may be a case/need for acknowledgement of peer discussion to be made by the students on submission of independent work. More widely, if this pattern of peer working is found to

exist in other contexts, should a question be raised about how much support from peers is acceptable? Whilst it is not the intention of the author here to suggest that informal peer working and some degree of collaboration should not be allowed in any circumstance, this question is posed as a serious reflection of how academics can encourage what actually takes place in professional practice (e.g. engineers working on problems in multi-disciplinary teams) whilst still ensuring fair, valid and robust assessment practices take place. In a real-life context multidisciplinary teams often work to solve problems but in academic environments independent work is often expected, is this an authentic, valid and realistic approach for students working on assignments? The definition of collusion by Carroll (2002, cited in Johnston, 2003) recognises that discussion between students can be a valuable learning experience however if an individual assignment is specified then the production of the assignment document must be solely the work of the individual. In some of the examples discussed in the interviews there could be cause to suspect that collusion may have taken place while students worked on assignments.

Standard student experience or module review questionnaires ask about peer work, for example, statements are used such as; *'Students supported each other and tried to give help when it was needed'* (ETL-Project, 2005). Statements such as this fall short of providing the detail of information gained in the study which can be used to understand why students have chosen to work together and specifically when students worked together what they did when working together?

As engineers of the 21st century are expected to have transferable skills and be able to communicate well and collaborate well with others the occurrence of widespread informal peer working could be supporting the development of these skills. If students could record/document their peer working in some way this could be used to provide evidence of the development of transferable skills.

Whilst it is accepted that students can learn a lot from each other it is questioned whether the opportunities for larger class discussion and deeper exploration of some issues may be reduced if students ask each other questions rather than addressing questions to the staff member which may prompt further discussion at deeper levels.

The question arises as to whether should staff consider how 'elitism' affects peer working, and whether it is within their remit to mediate informal peer working activities? Several other questions also arise on this topic; if similar abilities of student are working together is this seen in results, are there clusters around marks? Should programme teams consider students' current informal, and individual, approaches to peer working in their course design? Should this new knowledge of how informal peer working is taking

place affect the nature of how more formal peer working is used within the context; does it suggest there is less need for staff to construct peer and group work situations since students already choose when to work with peers themselves.

6.5.9 Spaces and Resources

Students felt that their comfort and the space they had affected how much attention they could pay to lectures. From both an organizational and pedagogic perspective care needs to be taken to provide workspaces in which students perceive they can fully concentrate on the task in hand. In addition to general opinions regarding space, specific attention needs to be given to allocation of teaching rooms at the start of the academic year. Further investigation is needed to determine how the negative perceptions of space so early in the academic year affect the learning practices at that point in time and beyond.

In terms of support for learning based on students perceptions of rooms and resources it would be worthwhile to explore further which aspects of these most supported students learning in addition to those mentioned specifically by students in the study (i.e. the use of spaces to revise and access to the eLP).

6.6 Theoretical implications

The literature review discussed three influential models by which to consider learning, the Biggs 3P model, the constitutionalist/relational model illustrated by Prosser and Trigwell, and the model produced by the ETL project. These models are discussed in the following sections with consideration against the results of this project. This section also considers other significant literature in the field engineering education and draws conclusions for the field.

6.6.1 Adapted 'Models of Learning'

The findings here demonstrate how closed attuned the notion of 'considering the context in which learning occurs' is with the holistic view demonstrated within a 'relational perspective of teaching and learning'. For the purpose of analysis this research has allowed the various components making up this specific context to be defined, although the examples have shown that the components are in fact simultaneously present during the learning practices.

The strong influences of students' perceptions make obvious the need to explore, and aim to understand, the ways in which students view and experience their teaching and learning context. Although the relational view of learning acknowledges the individual nature of the learning experience this research has taken the individual experiences and,

through the quantitative data, has summarised them for the cohort. Whilst acknowledging that some of the individual differences in experience may be lost by this method, the action of summarising at a cohort level has allowed tangible elements to be identified which can be more readily addressed by academics than the numerous variations which occur when looking at each individual.

The research in this study has built on the assumption by Lizzio et al. (2002) that 'research efforts addressing the impact of students' perceptions can be readily framed within Biggs's 3P model of learning.' Biggs' (1999) model clearly explains the three stages in the learning process and uses the term 'learning-focussed' to provide an overarching term to describe the 'process' element of learning (Chapter 2, Figure 3).

Whilst Biggs' 1999 model is closer in its association to the frame and the results of this current study (with its illustration of the bi-direction relationship between the elements) it is felt that the specific findings of this research relate directly to the Presage and Process elements of the 1997 model, with the recognition that student perception is influential in the learning process. The Trigwell and Prosser's 3P model (1997) shows the presage factors to include the teaching context. The results of this study suggest that the teaching context is not only a presage factor; it is also influential throughout the process stages. The 1999 version of the diagram summarises the process factor in the one term 'learning-focused', it is suggested here that this term over simplifies the actions taking place during the process stage. In addition to the 'process' the 'practice' of students has been investigated in this study directly and the results have also shown that students' processes are not always entirely learning-focussed, there were examples of it being achievement focussed and assessment focused.

Based on the findings of this research an adaptation of previous versions of the 3P model is required to demonstrate the learning process as has been described from a student perspective. This adapted version of the 3P diagram is shown on the next page by Figure 22.

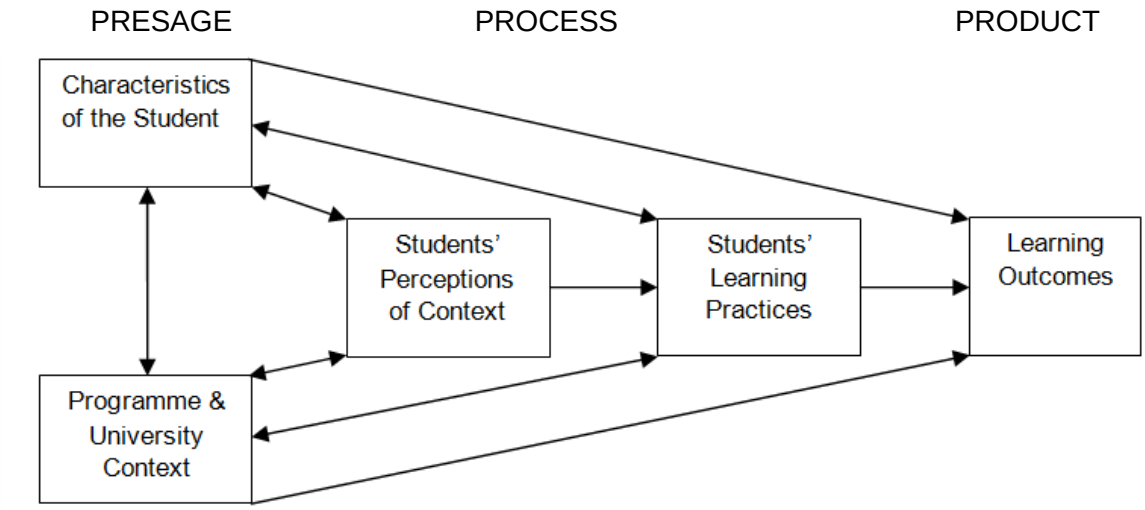

Figure 22: A modified version of the 3P diagram to reflect this context.

The results in this study have provided detail of the first two stages of the 3P model. In terms of presage factors, both student factors and teaching context were discussed in the qualitative stage and followed up in the quantitative stage. The above adaptation of the 3P diagram is produced in-line with what these results have shown for the learning and studying process within this context. The adapted model has stayed within the framework of the original model, showing a fairly linear series of factors which result in the product. In reality, the specific context of the teaching and learning has affected the linear nature of the model; adding a form of feedback and showing that the inter-related nature of the elements of the teaching and learning context influence students at all points up to the product stage.

The 3P model has been useful as a lens for analysing the results and has allowed some practical examples of what the presage and process stages in this mechanical engineering context actually look like. In the presage stage student characteristics such as prior experiences of subjects, preconceptions about HE and student orientations and motivations were influential. Aspects of the teaching context specifically were also influential such as timetabling of sessions, teaching styles and staff organisation, physical environment and also demands of the assessment. Students' expectations of HE (an example of a student characteristic) were highly influential in their perceptions (and therefore their practices) within the context.

From the modified 3P diagram it can be seen that students' learning appears to be influenced by their own personal characteristics and by their teaching context. This research has shown that included in students' personal characteristics are their expectations as well as their perceptions of the teaching and learning context. Students

held opinions about learning within the discipline such as what learning in engineering should look like and how engineering lecturers and student engineers should act within the higher education context. The research data also highlighted that there were aspects of the context itself which influenced students, such as the organisation of the timetable, the structure of the course and the composition of assessment tasks.

This research data has shown that the presage and process elements have a significant part to play in designing an effective engineering education context for students. In line with the 3P model - what students think, and what they experience, affects what they do. This research offers a student perspective on the constructive alignment of teaching and learning within the engineering education discipline. It is clear that those organising and implementing engineering education need to consider these two elements as they cannot be separated by the students during their learning experiences.

The findings discussed in this thesis are relevant in the first instance to the students learning within this context but they do suggest a wider relevance, and potential, for the design and implementation of engineering education throughout higher education.

6.6.2 Development of a Teaching and Learning Context Framework; Informed by the Student Perspective

As discussed in the literature review the ETL project produced a concept map (shown in chapter 2, Figure 7) which demonstrated elements of the teaching and learning environment which were viewed to support quality learning. It also identified items which contributed to the understanding of the teaching and learning environment. The results of this study have been used to produce an adapted version of the ETL concept map which in this case shows the 'inner' teaching and learning environment within the specific context of this research project, and more importantly, shows *the context from a student perspective*.

The qualitative and quantitative findings have been used to assist an understanding of how the second year mechanical engineering students perceive their own teaching and learning environment. The findings demonstrate the value of students' insight as major stakeholders within the teaching and learning context.

As can be seen in Figure 23 the four key areas of the conceptual map stay the same as the ETL model however it is the items identified within these that have been adapted in-line with the research findings. Taking each of the four key areas in turn the conceptual module in Figure 23 will be explained. The map is considered as a useful tool in providing a summary of the findings and understanding the range of factors which were present in this research.

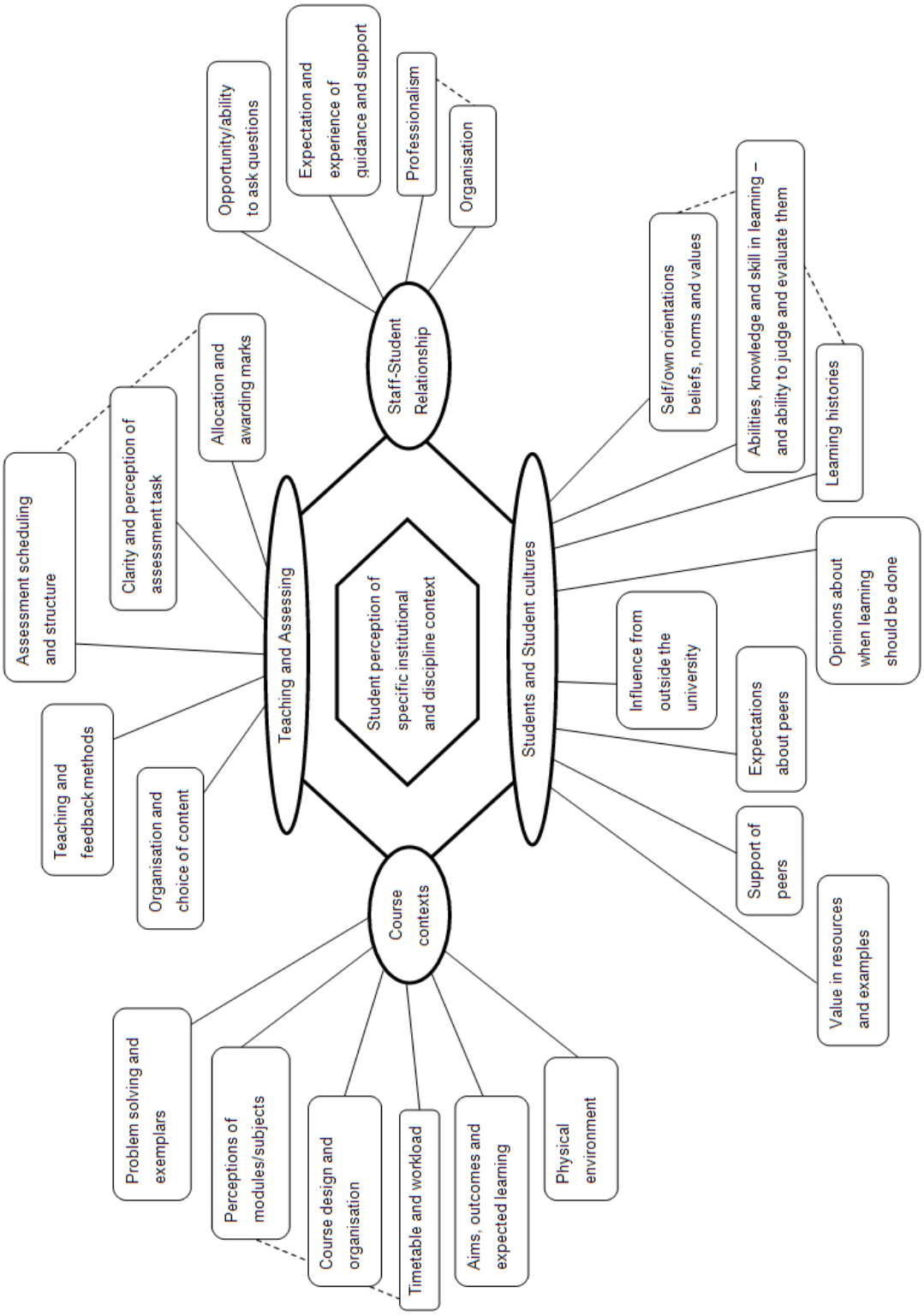

Figure 23: Student perception of the specific institutional and discipline context (structure of model adapted from Entwistle, 2003).

The key area of the 'staff-student relationship' has changed to include the primary elements that the students in this research referred to as influencing their relationships with staff. Student expectation and experience of support and guidance, their perceptions of staff organisation and professionalism, and the ability and opportunity to ask questions, were the factors identified as influencing the relationships between staff

and students. This is in some ways similar to the ETL model where 'sense of fairness' and 'moral order' could be assumed to share some of the features of professionalism. Whilst the ETL project gave 'guidance and support for learning' and 'affective quality of relationships' as two factors the findings used to produce the adapted model have combined them into one factor which also introduces the notion that the expectation about support can be similarly influential as the actual act of support. In addition to the items in the ETL diagram 'organisation' has been added to this area; this specifically relates to how students' perceptions of the member of staffs' organisation affects the relationship they then have.

The area of 'teaching and assessing context' for the most part remains the same as the ETL model however the area of assessment has been further divided to mirror the findings of this project. In the adapted model assessment is split into 'assessment scheduling and structure' and 'clarity and perception of assessment task'. The two are obviously linked (as shown by the dashed line) however they have been separated to highlight the two aspects of assessment that students referred to in the data. The structure of the assessment task was influential however the clarity of the task and the perception of the task for example, relevance or difficulty, also influenced students and were seen to be part of the items contributing to the teaching and assessing content area. The item of awarding and allocation of marks is included to reflect the perceptions students' had regarding how accurately marks were reflecting the learning they felt they achieved.

The course context identified in this research differs more widely from the ETL model than the two other aspects already discussed. This is to be expected as this shows a reflection of the particular context of this research, both in terms of the disciplinary context, but also in terms of the particular programme and institutional context. The item which has remained present in the adapted model is 'course design and organisation'. The aspect of 'contact hours and workload' has be subsumed into the broader item of 'timetable and workload' to reflect that that in addition to contact hours there are other implications of timetabling which influence students such as times of sessions, coherence of the timetable etc. The 'Aims and learning outcomes' category has been modified to also include 'expected learning' to again reflect how students perceptions were linked to their expectations of the environment. Three further items have been added to emphasise the findings from the data, these are 'importance of modules/subjects,' 'problem solving and examples' and 'physical environment', all of which were discussed by students with respect to their teaching and learning context. 'Choice for the student' has been removed as this was not an issue raised by the students in the data collection for this project; this may be because there are not

considered to be any elements of choice available to second year students in this programme; choices and options tend to be introduced more in the final year of study.

The final area outlined by the ETL model was the area of 'students and student cultures'. This is the area of the diagram which possibly differs most from the ETL project. Three of the items have been slightly changed however the intentions of them remain similar to the original model; 'influence from outside the university', 'learning histories' and 'orientation, beliefs, norms and values'. The area of 'abilities, knowledge and skill in learning' was expanded to include the 'ability to judge & evaluate them'. This was to represent the fact that some students identified difficulty in being sure of their own progress and also to reflect student quickness in making judgements based on how good or poor they believe themselves to be in a subject area. The 'peer groups, morale, identities' item was expanded to two items ('expectations about peers' and 'support of peers') to reflect the influence and presence peer working, expectations and relationships had in the data gathered for this research. The final item added to this area was 'values in resources and examples' which was included to represent the overwhelming value student in this context placed on access to resources and also to the availability of worked problems and exemplars. This final item may be one which is more closely tied with the discipline and the type of assessment tasks within this specific context.

6.6.3 Consideration of the Whole Teaching and Learning Context

In the previous results chapter, and now in the discussion of the results within this chapter, the interconnectedness of the data is extremely evident. The previous section within the chapter uses the adapted ETL model to demonstrate that students' learning practices could not be carried out in isolation to students' perception of the context nor were they carried out without influence from the structure and limitations of the context of the programme.

Whilst students clearly had some expectations and preconceptions before embarking on their course of study there were numerous occasions where perceptions were formed or influenced following interaction within the context. In line with Bloomer and Hodkinson's (2000, p.596) findings, context is shown by the data in this instance to unquestionably signify 'far more than simply the setting where learning is located.'

As this research is considered to be specific to the context in which it has occurred an effort has been made to analyse the data further to allow for a broader understanding of the findings and to support transference of key learning to the engineering education community. Through analysis of the data presented in Chapter 5, and above within this chapter, the context of the teaching and learning can be assumed to be formed by a

number of interrelated elements, these can be considered in the four key areas of context as outlined in Figure 23 (Teaching and Assessing, Course Context, Student and Student Cultures, Staff-Student Relationship). The four key terms can then be considered in terms of their sub-divisions, i.e. the Contextual Elements.

It has been shown by the qualitative results in this study that the individual contextual elements did not occur in total isolation from each other. Without defining their teaching and learning context explicitly the students described the contextual elements through their responses during the interviews. Through the interview process students provided examples which demonstrated the fact that multiple contextual elements were influential in their perceptions and subsequent practices.

Table 19 provides a demonstration of the way in which several contextual elements occur simultaneously during a teaching and learning activity, for example, during lectures. When considering student data regarding lectures, there were examples of references being made to elements from within the four areas of context that have been identified, for example:

Area of Context	Contextual Element	Example
Teaching and Assessing	Organisation and choice of content	*'Yes, when the lecturer seems confident and everything is planned out, it seems so much easier, you don't have to stress about 'Oh should I write this down? Do I need to know this or not?'*
Course Contexts	Physical environment	*'... at the start of the year, it was a joke... some rooms didn't have enough seats.'*
Course Contexts	Aims outcomes and expected learning	*'He came in and…he told us what we were learning…'*
Students and Student Cultures	Value in resources and examples	*'…he had the appropriate handouts and he went through everything…'*
Students and Student Cultures	Expectations about peers	*'I'm not really one for sticking my hand up in class… to do it in class is a bit rude I think.'*
Staff-Student Relationship	Professionalism	*'I find him unprofessional, the way he dresses, how he turns up, how he holds himself...'*

Table 19: Examples of the influences of multiple contextual elements

The example given here demonstrates the manner in which several elements of the context play a role in students' perceptions, which therefore inform their practices, and ultimately their overall teaching and learning experiences.

6.6.4 Consideration for the Context of Engineering Education

The research methodology used has continuously reinforced the fact that the findings of this research cannot be broadly generalised and be assumed to be true for all

engineering education contexts. Notwithstanding this, the findings have highlighted issues which can be considered to be relevant to other engineering education contexts.

This research suggests that a learning and teaching context, considered from a student perspective, would in fact provide an opportunity to design a more aligned learning experience; both in terms of aligning to students' expectations and in terms of ensuring that the type of learning which is encouraged is appropriate for engineering.

Considering learning practice, alongside an understanding of how course context influences students, can provide guidance on course design. For example, if deep learning is considered to be key for engineers then the course structure and context should be designed around situations which place this at the centre. Not being aware of students' perceptions and expectations in these cases however could still mean that students do not place value or importance on some activities and do not engage with them in ways that allows the desired learning to be achieved e.g. an overfull curriculum be have the effect of preventing deep learning and not giving time to reflect and absorb what has been learned. Without an understanding of how students perceive the curriculum, and their learning tasks, academics cannot be aware of what items they plan on 'learning later' or just being able 'to-do' so that they can pass an exam.

This research has allowed students perspectives to be brought to the forefront in an environment where there is limited opportunity to gather in-depth student views. The research has shown that in addition to designing teaching and learning in line with the university context, and general engineering education aims, the complexities of the student element *must* also be considered. Structure and programme context are generally developed through consideration of other factors such as staffing, room availability, number of contact hours, university timetable, regulations on assessment etc. It is not clear from this research that any of the factors which form the structure and context of a programme are considered from student perspectives, however in the interviews students did talk about factors which could inform design such as; overloaded curriculum, staff who they felt were less than professional, rooms that were not ideal, professional and helpful staff, useful resources and also facilities and assessment that did not help learning.

Students' expectations and perceptions affect many aspects of their learning. From this research it can be seen that students were considering questions such as; what has this subject got to do with my career plans, is this subject important, should students or staff behave in that way, how much support should they be given, how should they go about learning, how they should approach assessment tasks, should I help others? Some students were also considering; is attending worth it, do I really need to understand or

just pass…? The research has shown that there are many questions which students consider, and whilst staff remain unaware of questions they cannot respond to them and provide an improved teaching and learning context.

6.6.5 Relation of Findings to Discipline Specific Literature

The field of engineering education research has grown in recent years. Research within the field however needs to be applicable to practice; academics need to be able to make use of, and apply, research rather than teaching as they were taught. This research has provided an evaluation of students' teaching and learning experiences, without presence of any teaching and learning intervention. This study was not just looking at learning practices, or considering student evaluation based on their perceptions; it has combined both the practice and perception aspect to get a better informed representation of an existing context. In engineering education practice academics need to understand and have a clear image of what they expect students to do, what students actually do, and then identify strategies to close gaps between the two. This research provides the detail of what students do.

From the range of engineering education research literature discussed in chapter 2 it can be seen that there are several areas which have some element of commonality with the findings of this research, whilst not specifically addressing all of the same issues that this research did. The overarching nature of this exploratory design has highlighted that whilst studies can explore micro level of detail (such as learning of fundamental subjects, or learning on campus) they must acknowledge that the findings are part of a larger teaching and learning context which cannot be ignored. The research has shown how the different elements of the teaching learning environment and the student experience of it, are inextricably linked and must always be considered as such.

Of the studies discussed in the literature review which focused on student learning with respect to practices or perceptions, there are a few which can be considered to be closely related to this research study, these are the studies by Entwistle et al. (2005), Case (2000), Kember and Wong (2000), Scheja (2002) and Lim et al. (2010). All of the above studies have a focus on student learning in engineering disciplines in some respect.

Kember and Wong (2000) focused broadly on science and engineering disciplines (although their study did include third year Mechanical Engineers) and looked at workload and approaches to learning. Scheja's (2002) study looked at approaches to learning and the notion of delayed understanding within the engineering subjects of Computing and Electrical Engineering. Examples of research studies which focus particularly on specific disciplines of engineering are Case's (2000) research looking at

approaches to studying specifically in Chemical Engineering, and Entwistle et al.'s (2005) study which was focussed specifically on learning in Electrical Engineering. Lim' et al.s (2010) study also focused on the broad discipline of engineering to consider students' learning techniques and difficulties however the study did draw out specific findings for second year Mechanical Engineering students. It is therefore Lim et al.'s study which possibly has the most direct relevance to this study itself.

Entwistle et al. (2005) discussed students' perceptions of a subject being difficult and that there was a de-motivating effect for students when they failed to arrive at correct solutions to tutorial examples. This was an example of students' attitudes being affected by the perceived difficulty of the subject; where students gave examples of using surface approaches because they felt they were not getting good results from the effort they had originally put into the work. Suggestions of how to teach to encourage learning in Entwistle et al.'s study included that staff should show interest in the subject and its value, think out load while working out examples, provide worked examples with explanations and encourage students to discuss problems. Students' engagement with the subject was enhanced when they perceived continuity, coherence and connectedness with respect to the teaching of the subject. The data in this thesis shows that students also discussed examples of when they felt like their marks didn't reflect their effort or the learning they had achieved. Although from a different discipline some of the recommendations these students suggested echo Entwistle et al.'s study, such as being provided with worked examples and solutions. This suggests that whilst Entwistle et al. have suggested there are aspects of teaching and learning which may be specific to disciplines (i.e. Electrical Engineering), in this case it may be that the student action of seeking worked examples is actually common across the different branches of engineering.

Case (2010) discussed approaches and strategies which focussed on problem solving. Students' problem solving strategies were considered to be an adaption to the course context. Case described different approaches that second year students took to problem solving such as what they referred to as 'procedural deep' approaches, 'procedural surface', and also an 'algorithmic' approach. Case and Marshall (2004) suggested that a 'course focus towards a procedural deep objective might preclude the adoption of a deep approach'. It is suggested that this, alongside the previous topic of worked examples, may be linked to the frequency of procedural problem solving tasks which students are given within the engineering curriculum (as demonstrated in this thesis), and the fact that students are likely to be able to follow procedures and use formulae without necessarily having a deep understanding of the subject matter.

Although Kember and Wong's (2000) study was focused in Hong Kong, rather than the UK, their findings are still considered relevant to the discipline of engineering as a whole. Kember and Wong found that students' approach which combined memorising and understanding was related to perception of workload. This has similarities to the finding in this thesis where students reported that sometimes workload was too heavy to really learn something.

The SEM study (Lim et al., 2010) was specifically for evaluation of modules and as a result did not consider the whole teaching and learning context, nevertheless, it did draw some interesting findings relevant to this research. Lim et al.'s study focused on a range of engineering disciplines including second year mechanical engineering at an overseas campus. The students showed similar motivations to the students in this study in that they were career-oriented. The Mechanical Engineering students in this study reported to find two of their modules difficult, both of which were in the broad field of mechanics. This echo's the findings of this study where several students (in the qualitative phase) discussed their difficulties with mechanics. Students in Lim et al.'s study identified that incomplete handouts and the fast pace of module delivery caused difficulties in their learning process; again echoing some of the qualitative comments in this study and re-emphasising the value students seem to place on handouts. And in further agreement with this study the value students placed on worked examples could be seen, more than three-quarters of all respondents to the SEM 'believed that attempting more worked examples would be the solution to their learning difficulties' (Lim et al., 2010, p.56).

Scheja (2002) identified experiences of a particular lag in the process of coming to understand course material; this had similarities with some of the specific qualitative comments in this study about students feeling that they felt they learned after having a break or needing time on their own to really learn something. Scheja also reported examples of students taking steps to catch up which in the case of this thesis could be shown where students relied on support from their peers to get through the year.

This thesis recognises that there are similarities between the studies discussed in this section and the findings of this research. The previous studies however focussed on and have drawn out specific findings rather that aiming to understand them as part of much more complex student experiences. This thesis has shown that whilst there are results which reinforce findings from other studies, none of these however can be considered to be present in isolation to students other perceptions and practices within their teaching and learning context.

6.7 Methodological Findings

The use of mixed methods in the data collection has provided a rich source of information about the way students perceive and approach their subject. In addition to understanding how students perceive and approach their specific learning situation, this project has shown the mixed method techniques to be valuable in gaining feedback to assist in continuous improvement of practise. When discussing student teaching evaluations Onwuegbuzie et al. (2008) recommend that that mixed methodological approaches, should be used to obtain a more comprehensive picture of teachers' instructional effectiveness. The data collection methods used in this research has allowed a range of issues to be explored beyond the normal course evaluation, providing a much richer source of feedback on the students' experience of the teaching and learning environment.

This thesis demonstrates an application of a mixed methods design and suggests that it is highly suitable for use in teaching and learning research since it can respond to the complexity of ever varying context, not least from the teaching and learning situation but also with what the students bring to it, and their interpretations of it.

One of the strengths of mixed methods designs is considered to be the ability for research to develop as 'comprehensively and completely as possible' (Morse, 2003, p.195). The results gathered during this research show this is the case; both methods were needed to gain the appreciation of students' perceptions and also an understanding of students' learning practices. Integrating the results obtained through use of both qualitative and quantitative methods provided a greater understanding of the teaching and learning context that students were learning in.

The longitudinal nature of the data collection over two academic years allowed for a pilot study, and then two rounds of interviews in the main study, which were then used to inform the quantitative aspect of the design. The sequential nature of the data collection allowed the quantitative results to demonstrate that most of the cohort agreed with the views of their peers who were involved in the interviews. The ability to conduct quantitative exploration with almost the whole cohort reduced the bias of listening only to the views of those who had self-selected to be interviewed. Using mixed methods also allowed for it to be shown that not all the views expressed during the qualitative stage were representative of the larger sample; there were some points that the larger sample were either unsure about or disagreed with. Contrary to the interview data the methodology allowed it to be shown that the larger cohort agreed that it is appropriate to take up time in lectures asking questions and that they felt that seminar sessions were needed as staff did not do enough examples in their classes.

Some items which the methodology has highlighted as possibly needing further exploration are those which the cohort were unsure of, such as, how class tests allowed students to monitor their progress, which subjects were most important to mechanical engineers, the need for students to share with others, and the nature of how peer working takes place.

6.8 Summary of the Discussion of Results

The data gathered in this research project has allowed several features of the perceptions and practices of the cohort in this specific context to be identified. The results have shown the interrelated nature of the issues influencing students and have highlighted the importance of considering the whole teaching and learning context when exploring students' perceptions and practices.

Students judged their teaching and learning experiences based on their perceptions of themselves, the staff, the subject and also the structure, organisation and environment specific to the course context. Looking at students' practices such as what students do and why they do it may help in course design, in encouraging deeper approaches to learning, and also in improving student satisfaction.

The data enabled identification of: questions for engineering educators and has highlighted further research questions. Theoretical implications have been shown and methodological findings discussed.

The data has shown that there is a large amount of information that can be obtained through interaction and dialogue with students. Gathering information from students within the teaching and learning context can help to better understand what aspects of the context students feel are helpful, relevant and important to their learning. This understanding can then be used to inform engineering education at a range of levels; to help in the design of teaching activities, to inform course structure and ultimately to support the curriculum design and delivery process.

Due to the exploratory nature of this study a number of points which can initiate additional explanatory studies have been identified in this chapter. Further exploration is recommended within engineering contexts to really understand the relationships between students' perceptions of their teaching and learning context and their individual approaches and practices of study.

7. Conclusion

7.1. Introduction to Chapter and Summary of Research

This thesis has described the application of a mixed methods methodology, from the justification of its selection, the process of data collection, the consideration of quality, and the data analysis. This detailed account of the methodology will be valuable to those considering making use of a mixed methods sequential exploratory design.

With relation to the research question students' perceptions of their teaching and learning context have been described, as have their learning practices. In considering these areas the results have also shown the interrelated nature of the issues influencing students and have highlighted the importance of considering the whole teaching and learning context when exploring students' perceptions and practices.

Students judged their teaching and learning experiences based on their perceptions of themselves and of the staff who taught on their programme. Their judgements were also based on perceptions of the subject, the programme structure, organisation and the university environment.

The data has shown that there is a large amount of information that can be obtained through interaction and dialogue with students. This information can help inform the stakeholders within the teaching and learning environment so that it is more aligned to students' expectations and can reflect, and also respond to, their practices. Looking at students' practices such as what students do and why they do it can help inform course design and have implications for improving student satisfaction.

This study has allowed the author to determine what supports or prevents learning within this context and has provided data to inform strategies within teaching to encourage more consistent approaches by students, more pro-active and more satisfied, independent students, who make use deeper approaches to learning.

7.2 Review of the Research Question

7.2.1 The Final Research Question

This thesis has introduced the reader to the context of a specific teaching and learning environment in mechanical engineering.

The theories and literature discussing Surface and Deep Approaches to Learning, Perceptions of Learning, Inner Logic of the Subject and Contextual Factors influencing Learning were used initially to guide the research.

The research question identified initially was:

> *"How do contextual factors influence the approaches, and perceptions of, undergraduate mechanical engineers?"*

In the design of the research and following the pilot study it was clear that there was more to be learned regarding the practice and process of students' learning than just the approach (in terms of surface or deep). Students discussed a number of factors and strategies which were related to the practice of their learning within this context which demonstrated the complexities over and above approach, these included; independent working, working in peers, use of handouts and examples, questioning behaviour and attendance.

The research question from this point was then expanded to:

> *"How do contextual factors influence the perceptions and practices of undergraduate mechanical engineers?"*

By adjusting the order of the terms in the question it reflects the pilot findings, the literature, and the main study findings which all demonstrated practices were affected by perceptions.

7.2.2 The Research Question Answered

In simple terms the answer to the research question is that the context has been shown to influence both what students think and what they do. The findings have shown that the theoretical framework (which was informed by generic teaching and learning literature) has held true within this specific engineering context; contextual factors constantly affect both the perceptions and practices of students.

The nature of this study has shown that assumptions should not be made about how students will carry out their learning practices. Students must be recognised as stakeholders in their teaching and learning context. Student feedback is valuable in understanding how they perceive the context in which they learn and how they go about the practice of their learning as a result.

Aspects of context such as the course, the assessment, relationships with staff and other students influence the practice of when students will learn, how they will learn and who they will learn with.

Within this study it can be seen that several elements of context did not support students in developing autonomous approaches (e.g. reliance on worked examples, handouts and

feedback) or help them in developing their understanding of engineering as a broad and complex field (not valuing all subjects and engaging in some surface learning).

Other aspects of the data demonstrated the ways in which the context supported more positive perceptions and practices of students such as teaching methods which met with expectations, availability of resources and the strength of peer support networks.

The following two sections evaluate the progress of the research against the aims and objectives.

7.3 Review of Aims and Objectives

7.3.1 Review of Aims

The first aim of this research project was to identify how students perceived their teaching and learning environment, considering what contextual factors influence the students' perceptions of the programme. This aim was met and is evidenced particularly through the qualitative comments summarised in section 5.2, and in tables 7 – 11.

The second aim was to identify how the contextual factors influence the students' in their approaches to learning and their learning practices. The way in which this aim has been addressed differs slightly from the original intention. Rather than identify specific contextual factors with influence learning practices, it became apparent that the context consisted of so many inter-related factors it was impossible to isolate them. This research therefore identifies students' practices as influenced and informed by the overarching, and ell-encompassing context. Context is understood and has been determined by the elements which students identified as affecting their learning practices.

The integration of the qualitative and quantitative results allowed the perceptions and practices of the cohort to be identified, thus providing an overview which could be used to consider teaching of the cohort and not an isolated number of students.

An additional aim of this research was to consider mixed methods research and its suitability as a methodology for engineering education researchers to adopt. This is reviewed in section 7.4.

7.3.2 Review of Objectives

The discrete objectives of this research were addressed throughout the thesis with the literature review providing an understanding of the current status of engineering education research.

The qualitative data provided an insight into the perceptions and practices of the students and provided the detail to support the development of a quantitative instrument. The instrument was used to collect quantitative data to further elaborate on the qualitative data.

The two data types were combined to allow a full understanding of how the cohort perceive their teaching and learning context and also what practices and approaches they use within their learning.

The final two objectives; to evaluate the use of the mixed methods methodology and to consider the findings of the study relevant to the specific context and to the research field of engineering education are also addressed. The evaluation of the use of the mixed methods methodology and the consideration of the findings relevant to the research field of engineering education are addressed in the following section.

7.4 Review of the Methodology

The use of mixed methods of enquiry prevented the research being limited by the results which would have been available through using only one method. Although the dominant source of data in this study has been the qualitative data the quantitative data has been well integrated with it to give a much more detailed understanding of the research findings. The methods used mean that it is not possible to use the quantitative data to make statistical assumptions relevant to the wider populations. This is acknowledged as a limitation of the study however it is considered to be acceptable as the quantitative data in this instance was obtained to support and supplement the qualitative results rather than to make wider inferences.

The methodology allowed aspects from the literature to be explored and confirmed to be true within this context. Students were affected by their interactions with lecturing staff; however in this case it was found that negative interactions were more likely to affect the overall learning experience rather than actually put motivated and committed students off learning. Lack of clarity and goals did affect students approach to work as did a feeling of high workload and demands on their time. Students also felt that access to resources and the learning environment were influential to their practice of learning.

The Student Satisfaction Approach (Williams and Cappuccini-Ansfield, 2007) has been adopted in several institutions and can be assumed to be the approach for evaluating teaching and learning most similar to the mixed method approach in this study. The difference being that in the student satisfaction approach students suggest and develop the questions that will be asked in the questionnaire, and in this mixed method approach a number of interviews were had to ensure all aspects of the teaching and learning could

be discussed and then it was the researchers interpretation of the data which led to the questionnaire development. Whilst the student satisfaction approach would allow for elements of context to be considered it would be more narrowly focused by the direction of the questioning that students developed, the use of semi-structured interviews allowed ideas and views to emerge as the interviews progressed which may not have been highlighted and developed into questions if the student satisfaction approach had been used. The mixed methods approach allowed the context and complexity to be appreciated, and provided a dimension to the research and the analysis which could not have been achieved from using standard teaching and learning inventories.

A report to the Higher Education Funding Council for England stated that, to improve learning within a module, the use of direct, qualitative feedback is preferable to questionnaires (Harvey, 2001, cited in Lim et al., 2010). Although this refers to a module the same can be considered to be true for a programme. In an ideal situation direct qualitative feedback would be obtained from all students within a cohort however this is not practical both in terms of time and also in terms of variation in student time commitment to providing rich qualitative data. The use of mixed methods allowed direct qualitative information to be obtained from a sample of students who agreed to be involved in the research, this could then be verified quantitatively, and with much less time commitment, by the majority of the cohort who agreed to complete the questionnaire.

7.5 Contribution of Research to the field of Engineering Education Research

The development of the 3P and the ETL models show how this study is situated within current literature. The process of data analysis has enabled the learning context (as portrayed by the students) to be presented through the qualitative data and represented in the refined models.

By understanding students' learning, and their learning experiences, the complexity of the teaching and learning process can begin to be properly understood, so that informed evaluations and improvements can be undertaken. Students' feedback is insightful and gives information from a perspective which could not be gained in any other way. This thesis has provided a way of ensuring these insights are documented such that they are of value and offer a significant contribution to those within the field of engineering education research.

Findings of this thesis, considered alongside the other studies considered from within the engineering disciplines, help to form a picture of students' perceptions and practices

which may now be considered to be specific or particularly relevant to engineering. These include:

- Students don't always see their effort and learning reflected in marks.
- Students believe worked examples with help them move their learning forward
- Students have problem solving strategies; which include seeking help from peers
- Students' practices and approaches are related to their workload.
- Students find some subjects more difficult that others; mechanics being one of the more difficult subjects
- Student place value on handouts.
- Students are career-orientated.
- Students need time to understand course material.

7.6 Delimitations of Scope and Key Assumptions

The scope of this research is acknowledged as being constrained by the research setting and the access of the researcher. The setting was chosen firstly for the reason that it is a fairly typical traditional-style of mechanical engineering course in the UK (which is accredited by the Institute of Mechanical Engineers), and secondly for the ease of access for the purpose of data collection.

The research site is a Post-92 university where the focus has traditionally been on teaching and learning rather than it being a leading research institute. Although this is changing in current times the university still prides itself on its student centred focus; evidenced through practices such as the 'open-door policy' as mentioned earlier in this research.

The possibility of bias is acknowledged in that the researcher is a graduate from the same academic discipline at the research site and therefore will have their own ideas and perceptions of the discipline and the teaching and learning within it. Every effort has been made for the researcher to form judgements and opinions in this thesis only based on the data collected and not any pre-conceptions of the researcher. The researcher also had a break from the institution of several years with time working in industry and school level education which therefore meant any personal feeling were diluted by the time of returning to the institution. The programme had undergone several changes and therefore bore very few similarities to the programme originally studied by the researcher.

Whilst the researcher opinions have not been used it is acknowledged that interpretation of data is a personal exercise so the researchers' background may be an influence which requires acknowledgement. The researcher's background was considered more to be of

benefit in this research as it made the environment of the research more quickly understood by the researcher and it meant that aspects of the curriculum, learning techniques and teaching styles that were discussed by students could be easily understood by the researcher.

Power relationship of the researcher and the sample is also acknowledged. Being a lecturer on the programme under investigation may suggest that there is an imbalance of power however the research methodology and the questions asked were in ways such that focus on individual staff was not the attention, the focus was more on what students did in their learning and why. At the start of the research the researcher was not a full-time member of staff and was not co-located with the other lecturers on the programme. The researcher also did not hold any position of authority within the teaching team; was not module tutor, programme leader or head of any year group.

Whilst the engineering background and the position of the researcher are both acknowledged as possible influencing factors to the research they are also first and foremost acknowledged as positive factors. The research, which is exploratory in nature, needed the researcher to have a good understanding of several aspects of the teaching and learning environment. It helped that the researcher understood the programme structure, knew what subjects students were referring to when they mentioned module codes, and understood the assessment structures and timetabling factors. The researcher also needed to understand the discipline to understand the significance of teaching styles, learning practices, the wider context of the discipline and the significance of any discipline specific content that was discussed.

A caveat to the findings, results and discussion is given here. The data gathered only gives a ‘snap-shot’ in time as programmes are constantly evolving. From the start of this research to its time of completion there have already been several structural changes to the programme, mainly in terms of module size and content, and rationalisation of the assessment to reduce assessment bunching and to ensure a similar level of work is required to achieve the same number of credits across the programme. Although the structure of the programme has changed there has been little change to the teaching within it; except from the usual turnaround of staff bringing their own teaching styles.

7.7 Summary of the Research Findings and Opportunities for Further Research

This research has met the aim of highlighting the importance of considering students’ perceptions and practices. It has also enabled some of the barriers to high quality learning to be identified. In meeting this aim a number of points have been identified which suggest opportunities for changes to practice. Due to the exploratory nature of this study the research has also identified a number of issues which deserve

investigation and further exploratory study. The changes for practice and opportunities for further exploration are considered to be relevant within this context, within other mechanical engineering settings and also in broader engineering education contexts.

Specifically these findings suggest that engineering educators should:

- Take time to explain theory behind formulae to reflect students' desire to understand and to support students in developing a deeper conceptual understanding.
- Understand which subjects students feel are more important and assess whether these perceptions are an accurate reflection of the courses' intentions.
- Communicate intentions of teaching sessions and assessment methods to enable students to understand purpose.
- Acknowledge that the inter-related nature of the contextual factors may sometimes mean that students are directed towards more surface type approaches rather than the deeper approaches and level of understanding that they claim they want to achieve.
- Develop a better understanding of which subjects are dominating students' study time.
- Consider the procedural nature of the teaching activities and assessments and how this relates to reliance on worked examples and handouts.
- Determine the role of independent learning within programmes and consider the way in which this is communicated to students.
- Consider the extent and nature of peer working; understand how it is used by students within a given context and make it explicit to students when peer working is not acceptable (e.g. in some assessment tasks).
- Strive to achieve a balance between providing students with an element of pressure and providing a curriculum/workload which is too heavy.
- Take on board and explore further the professional expectations of students who are preparing for a career in a professional sector.

In terms of moving engineering education research forward it may be also beneficial to better understand what influenced students' orientations and expectations of Higher Education; whether these were present at the start of the course or to what extent these were shaped by the course itself? Further research could consider whether students' orientations towards study and higher education are the same in other years of this engineering programme, in all mechanical engineering courses and also in courses within other engineering disciplines?

This research has only just begun to explore the context of teaching and learning in mechanical engineering at this level of study. The action points should be addressed to support the practice of engineering education. The additional exploratory studies should be undertaken to explore the issues highlighted in this thesis for the further benefit of the engineering education research community.

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9. Appendicies/Accompanying Material

APPENDIX A: Journal Publication - Perceptions and their influences on approaches to learning

APPENDIX B: Journal Publication - Perceptions and their Influences on Approaches to Learning

APPENDIX C: Journal Publication – Do different learning contexts, processes and environment affect perceptions, dispositions and approaches to learning?

APPENDIX D: List of Additional Publications

APPENDIX E: The Broader Workings of the Programme

APPENDIX F: Information Sheet

APPENDIX G: Consent Form

APPENDIX H: Example of an Interview Schedule

APPENDIX I: Coding Example

APPENDIX J: Excerpt from a Lecture Observation (pilot Phase)

APPENDIX K: Quantitative Tool

APPENDIX A

McDowell, L., Penlington, R. And Tudor, J. Practice and Evidence of Scholarship of Teaching and Learning in Higher Education. Vol. 5, No. 2, October 2010, pp.75-97

Improving engineering education by investigating students' perceptions and approaches towards learning

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Abstract

A Mixed Methods research methodology is suggested in this paper as a suitable model for the process of evaluating teaching and learning. The aim of this paper is to introduce some findings which have been obtained from research into teaching and learning within engineering at a UK Higher Education Institution.

Students' approaches, and the effects their perceptions have in determining their approaches to learning, have been explored. The data gathered highlighted some issues with regard to teaching and learning that are relevant to a range of courses and that can inform the quality enhancement of teaching provision. It is suggested that a mixed methods evaluation has advantages over standard institutional teaching and learning evaluations in allowing a greater understanding of the learning situations students encounter, how these situations are perceived, and how they affect students' learning behaviour.

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Amongst the issues raised by the research is the notion that students have definite ideas, expectations and opinions about their learning contexts. The concept of importance emerged to show that students were identifying perceptions and approaches to learning based on their importance rating of a subject. Patterns in students' questioning behaviour were also identified, highlighting possible limitations to students' academic development within lectures.

Keywords: Approaches, Perceptions. Students, Mixed Methods,

Introduction

It is widely acknowledged that, if we want to improve education, we need to take into account the views and experiences of students. Informally, this is part of good teaching and takes place through interaction and dialogue between staff and students. More formally, quality enhancement is defined by Biggs (2003) as being "about the continuing improvement of teaching in the institution" (p.269). Higher education practitioners concerned with quality of teaching and learning should be looking at employing methods to understand and evaluate teaching and learning effectively and to consider how we can further enhance teaching quality. Within higher education, collecting feedback from students on their experiences of teaching and learning has become "one of the central pillars of the quality process" (Williams & Cappuccini-Ansfield, 2007, p.159). However, the main tools used within quality processes are standardised, structured questionnaires. In this paper we review the use of these methods and present a detailed example of an alternative approach to gathering data from students. We suggest that the type of mixed method approach presented provides much richer and more reliable evidence to inform teaching and learning enhancements and is a suitable and adaptable model for the process of evaluating teaching and learning.

Students' approaches, and the effects that their perceptions have in determining their approaches to learning, were explored using qualitative and quantitative data collection methods within engineering at a UK Higher Education institution. The data gathered highlighted some issues regarding teaching and learning that are relevant to a range of courses and that can inform the quality enhancement of teaching provision. The work presented here was undertaken during the first stage of an ongoing project which is

investigating students' perceptions and approaches within an undergraduate mechanical engineering programme. It is also significant to note that these issues would not normally have been uncovered during the course of teaching sessions or during the "normal" institutional course evaluation and Quality Assurance procedures.

Context of the Research Project

Within the field of engineering education, existing studies have tended to consider teaching and learning in two ways; in a generic module/programme evaluation sense using pre-defined questionnaires, or with respect to evaluation of small-scale teaching innovations. There are examples of in-depth context-specific investigations in electrical engineering (Entwistle, Nisbet & Bromage, 2005) and chemical engineering (Case, 2000). There is less evidence, however, of published information which evaluates students' experiences in mechanical engineering. Whilst there can be assumed to be similarities between the speciality engineering disciplines, there is a wide diversity of subject areas within the discipline of engineering (Baillie, Lamb & Bramhall, 2001) and therefore it should not be assumed that students within the specialities regard teaching and learning in the same way. This paper presents and discusses the research findings to date for a context-specific evaluation of teaching and learning in mechanical engineering.

The purpose of the investigation discussed in this paper (and as the first stage in an ongoing project) was to investigate the perceptions and approaches of students in a second year undergraduate mechanical engineering cohort. The research was carried out to determine how students were conducting their learning and also to understand what students perceived to be important to their learning and to their success in the programme. The research was also designed to investigate how students perceived the context which surrounded their learning including: specifics of the curriculum; relationships with staff; classroom environment; teaching delivery; and assessment.

In the programme of study selected for this research, students experience weekly lectures supported by weekly tutorials and a programme of practical laboratories. The tutorials generally allow the concepts that were introduced in the lecture to be discussed

by students and staff in smaller groups and also allow students an opportunity to work through some example problems and gain feedback on their progress. Engineering courses traditionally have a pattern of several fundamental engineering theory modules in each year of study; Maths, Mechanics and Thermodynamics/Fluid Mechanics. These classes are often assessed by small amounts of coursework (lab work, assignments, in-class tests), with a large weighting given to an end of year exam. The remainder of the taught time then often consists of more discipline-specific classes which may, or may not, reoccur in further years of study.

Evaluating Teaching and Learning

Jones, Siraj-Blatchford and Ashcroft (1997) explain how evaluation of courses can provide useful data for informing institutional direction and curriculum development. Green (1994, p.100 as cited in Haselgrove, 1994) reports that students, as "*consumers*" of higher education are now expected to have views about the quality of the services offered to them. Student feedback is often collected through use of course evaluation surveys, student satisfaction surveys, or nationally in the UK, through the National Student Survey. All of these tools explore, in some way, students' perceptions and experiences of teaching and learning. Feedback can be collected from students on a range of issues such as individual course components, the learning experience, personal study environment and the outcomes achieved (Kember, Leung & Kwan, 2002). Many universities make use of student feedback questionnaires near the end of each semester with Kember et al. (2002) suggesting that "they must be the most widely used form of teaching evaluation in higher education" (p.411)

The structured evaluation questionnaires that are used in institutions tend to be part of a long review cycle; they are usually the same set of generic questions asked each year of the student cohort. When these questionnaires are used, the aspects of teaching and learning which can be evaluated are ultimately defined by the focus of the questionnaire. The generic institutional questionnaires are often worded so that they can be used across departments. This may therefore mean that a teacher using less traditional or more innovative approaches to teaching may score low on a standard questionnaire, even though high quality learning may have been achieved by the students (Biggs, 2003). Questionnaire evaluations may also be rushed at the end of the

course, which in itself can lead to tutors obtaining feedback which is disappointing (Jones et al., 1997). Jones et al. give an example of a course evaluation which makes use of a "structured list of questions" to encourage constructive criticism to take place. Example questions used in the evaluation discussed by Jones et al. are "To what extent do you think the objectives of the course have been addressed? Which elements of the course have you (a) enjoyed, (b) found useful? Do you have any suggestions for next year?"

A number of institutions have introduced a degree of standardisation to their questionnaires, while still allowing faculties and departments the opportunity to add to, or modify, questionnaire content. The most common focus of evaluation questionnaires is the individual module, although the majority of institutions also gather feedback data at other levels (Brennan et al., 2003). The format of student experience/evaluation questionnaires, and the effort required from students to complete them, can vary. In general students are asked to rank variables on scales which are considered to be essential to teaching and learning, although formats might also include 'tick-box' forms or contain spaces for qualitative comments to be provided by students (Johnson, 2000). Mathias (as cited in Aylett & Gregory, 1996) provides an example of an institution which suggests two options for faculties carrying out evaluation; that they make use of a standard student questionnaire which can be modified if required, or staff can devise their own questionnaire as long as it contains two compulsory questions to allow summative comparison over courses and teachers. The two compulsory questions are overall (a) how would you rate this course, and (b) how would you rate the lecturer?

Several of the studies investigating students' experiences discuss the Course Experience Questionnaire (CEQ), as developed by Ramsden (as cited in Lizzio, Wilson & Simons 2002., Broomfield & Bligh, 1998). The CEQ is concerned with teaching (good teaching, clear goals, appropriate assessment and appropriate workload), overall quality and the acquisition of generic skills for the workforce (McInnis, Griffin, James & Coates, 2001). The questionnaire asks students to agree or disagree (on a five point scale) with statements about their perceptions and experiences during their course. A question is also included which asks students about their satisfaction with the overall quality of the course, as customer/consumer satisfaction in a higher education institution is considered to be the "proxy assessment of quality" (Mazelan et al., as cited in Harvey &

Green, 1993). Satisfaction can also be considered as the extent to which the "product" (in this case the student experience) is consistent with expectations (Harvey & Green, 1993).

Biggs (2003) suggests that questionnaires which are used to give feedback regarding teaching and learning actually make much more sense when questions are tailored to courses and situations, and where the questions can give feedback which is specific. Williams and Cappuccini-Ansfield (2007) explain that one of the more popular approaches to collecting feedback from students within individual institutions is the Student Satisfaction Approach and a number of institutions, both in the UK and overseas, have adopted the Student Satisfaction Approach as a central tool in their quality management processes. Williams and Cappuccini-Ansfield (2007) discuss the differences between student satisfaction surveys and the National Student Survey (NSS).

They explain that student satisfaction surveys aim to measure satisfaction with all aspects of the student experience and are tailored to the needs of students at a particular institution, whilst the NSS aims to broadly measure the concept of quality using a single format that can be used at all higher education institutions. In a study undertaken on behalf on the Higher Education Academy (Machell & Saunders, 2007), it emerged that the results of the NSS were being used (or intended to be used) alongside institutions' own quality assurance processes, such as student evaluation questionnaires, to identify weaker areas within institutions. Unfortunately, although the NSS does include some questions which may indicate why the students' experiences may be rated as low during some part of their total period of study, the survey does not provide the opportunity to really explore the complex reasons behind poor student experiences. It also does not allow institutional/course specific issues to be investigated.

Much student time is taken up by questionnaires and surveys. If Lecturers and Institutions in general wish to get useful data from the questionnaires given to students, they need to consider the frequency and also the design of the specific instruments which they use. Brennan et al. (2003) recognised that "perhaps the most serious limitation" of the instruments that focus upon students' evaluations of particular modules or course units is that they provide little information about students' experiences of their programmes or their institutions as a whole. Students receive institutional

questionnaires as well as questionnaires from their departments of study, student union etc. and may be faced with more than 20 questionnaires per year. Whilst acknowledging the advantages of questionnaires in that they are quick, anonymous and amenable to statistical analysis, Race (2006) discusses the "Ticky Box Syndrome", where people who encounter excessive use of questionnaires become likely to make instant responses to questions, with responses made using surface level thinking rather than as a result of reflection and critical thinking. The use of quantitative inventories to obtain student feedback is considered by Brennan et al. (2003) to be dictated by purely organisational constraints, such as increasing size of classes in higher education. However Brennan et al. recognise that standard instruments do have advantages; they can provide opportunities to obtain feedback and to document the experiences of the student population.

Students Approaches and Perceptions

When considering course or programme evaluation from a scholarship of teaching and learning perspective, it can prove invaluable to be aware of the perceptions students have of their learning and to understand how these have influenced students' approaches to studying/learning. Being aware of students' perceptions and approaches can be useful to staff for reflecting on their teaching practices, and in the design or implementation of modifications to teaching methods or activities.

Another approach to teaching and learning evaluation, in addition to considering students' evaluations of their experiences, is to consider the quality of learning achieved by students. "Quality of learning" is recognised as a complex phenomenon and it is, therefore, problematic to define and measure. A more tangible concept to identify is the underlying approach or approaches to learning that students have taken. If a deep approach has been taken by a student then the assumption can be made that higher quality learning outcomes will be achieved (Prosser & Trigwell, 2001). The terms "deep learning" and "surface learning" were originally used to describe the qualitatively different levels of processes or approaches that students took to any learning situation (Marton & Säljö, 1984). Positive correlations between the quality of outcomes of students' learning and the approaches they take were identified by Svensson (1984).

Students' approaches to learning can change during a programme of study; they are influenced by students' perceptions of their learning environment (Bloxham & Boyd, 2007) and can also be affected by students' expectations within a programme (Harvey & Knight, 1996).

"Student learning is a result of an interaction between a student and the learning situation, and this is unique for every student in every different learning context" (Bloxham & Boyd, 2007, p.69). With the previous statement in mind, it is suggested that for staff "one of the most important criteria for determining the effectiveness of a particular teaching style is how the students respond and learn in the environment you have created" (Jones et al, 1997, p.91). Useful indications of effectiveness and quality of teaching can therefore be achieved through consideration of what students say they do in a particular context; both in terms of their approach towards their studies (engaging in surface or deep learning approaches) but also in their wider behaviours (motivation, interest, attendance etc.) at particular stages during a course. As the context of higher education is changing (Fry, Ketteridge & Marshall, 2009) it is suggested that, when examining relationships between research and teaching, the changing context must be considered (Brew, 1999). Benson and Samarawickrema (2007, p.61) explain that context may include a "range of factors in its definition, from the specific characteristics of the learning and teaching environment, to disciplinary, institutional and systematic variables, and beyond that to broad social influences and personal issues affecting students' lives".

The breadth and complexity of the factors we seek to evaluate are also demonstrated by Entwistle (2008), who identified that students' perceptions of the teaching and learning environment essentially affect their learning approaches more than the actual teaching/learning environment provided. Taylor and Hyde (2000), meanwhile, discuss that research has in fact shown a chain of relationships linking students' concepts of learning, perceptions of teaching and learning, approaches to learning, and quality of learning outcomes. Students, for example, will not necessarily tackle assessment tasks in the ways staff may expect because they may have a different perception of the meaning of the task (Laurillard, 2002). To really understand how students view and experience teaching and learning, it is therefore proposed that evaluations should focus on what students perceive to be "key aspects of teaching" (Brennan et al., 2003, p.33).

Studies in the USA, investigating the relationship between certain out-of-class activities and the quality of student learning outcomes, have suggested that there will be many factors associated with learning that lie outside the control of the individual academic or department (Erwin & Knight, as cited in Harvey & Knight, 1996). Murray (as cited in Harvey & Knight, p.148) explains, for example, that "the main factor determining student learning... is individual studying by students outside the classroom." Based on this view, the evaluation of teaching and learning should therefore also consider what work students have been encouraged to do in their own time. The way students evaluate and consider a module may also be related to the different types of student; there are those who are motivated with "clear academic or career plans" and there may also be others who are there to "get qualifications for jobs" (Biggs, 2003, p.3). This would support the notion of an evaluation method which would allow some of the background of the individual students to be understood to assist in the interpretation of the data.

Taking into account the literature presented thus far, it is suggested that evaluation of quality and effectiveness in teaching and learning should not be over-simplified to a situation which only allows for ratings and responses to be obtained through standard course evaluation questionnaires. Evaluation must allow for information to be gathered on how students have carried out their learning and to allow any influential factors specific to a particular teaching and learning context to be considered. This study describes an approach to evaluation which provides a more holistic view of students' evaluation of teaching and learning; it allows the practical element of how students approach their learning to be explored, it explores students' perceptions, and it investigates how students may be influenced by their teaching and learning experiences.

A context based approach to evaluating teaching and learning

As Biggs (2003, p.2) identifies, what works in teaching is "a complex resolution between us and the system that operates in the particular institution in which we are working." We have to adjust teaching within the context in which we are working; including its relationship to subject matter, resources, students, and our own strengths and weaknesses. As we have to adjust our teaching, we also need to consider our

evaluations in the same manner to ensure that they are the most appropriate for what we are trying to find out. Making use of a mixed methods strategy for evaluation allows for rich and valid data to be obtained through a more research focused technique, rather than through a normal institutional evaluation or review.

Jones et al. (1997) suggest that staff should run an evaluation session with students towards the end of a course where students are asked to identify aspects of the course which they think should be included in an evaluation sheet. An evaluation sheet can then be produced which focuses on these points, as well as including aspects of the course that the member of staff wishes to evaluate. Race (2006) suggests a similar method for teaching review, where he introduces the possibility of using preliminary interviews with a representative selection of students to establish the agenda for feedback questionnaires. This method is reflected in the student satisfaction surveys undertaken at the University of Central England (Harvey & Knight, 1996) which show a context specific approach to evaluation. These surveys focus on the total student experience and highlight key issues in students' perceptions of quality (Green, 1994, as cited in Haselgrove, 1994). The surveys include a set of "satisfaction" items which are identified by student focus groups (Williams, 2002). Completion of the survey by a larger sample of students allows the importance of the items to be determined.

Mixed Method Evaluation Research Design

The evaluation method applied in this project is based on a sequential exploratory mixed methods research methodology, where both qualitative and quantitative data are used to give a better understanding of the phenomenon under study. This paper discusses the first phase of the design, where qualitative data was used initially to gain an understanding of the situation. This exploratory design "is characterized by an initial phase of qualitative data collection and analysis, followed by a phase of quantitative data collection and analysis" (Creswell, 2003. p.215) with priority given to the qualitative aspects of the study. The information gathered during the qualitative stage will be used to develop a theory regarding the teaching and learning experiences of students. A context specific quantitative instrument will then be designed which can be used to gather data and explore the theory with a wider sample. It is this form of mixed method design that is suggested as a suitable method for evaluation of teaching and learning.

Figure 1 shows the detail of the sequential stages undertaken during this project to develop a theory to understand students' perceptions and approaches to learning within a given context. The notation of 'QUAL' is used to represent the dominant qualitative source and 'QUAN' to show the less dominant quantitative source used for validation purposes (Morse, 1991).

Figure 1. Exploratory Sequential Design Detail (Creswell & Plano-Clark, 2007, p.58)

In this study the qualitative data was obtained through interviews and observations, and the quantitative data will be gained through completion of a likert-type rating scale questionnaire developed following analysis of the qualitative data. This method of developing and administering a questionnaire based on previous findings allows the qualitative data to be verified against a larger sample. It also reduces the likelihood of bias which may occur through only gathering qualitative data from a small sample of students.

The full cohort was 51 and from those a sample of 6 students, made up of both part time and full time students (4 full time and 2 part time, which was similar to the full time to part time ratio in the class) were interviewed during this stage of the research. A semi-structured interview format was used to allow students' perceptions of their learning contexts and their approaches towards learning to be explored. Classes were observed to allow the schedule of interview questions to be informed and therefore questions specific to the context to be prepared.

When discussing student evaluations of teaching, Onwuegbuzie, Daniel and Collins (2008) recommend that that mixed methodological approaches should be used to obtain a more comprehensive picture of teachers' instructional effectiveness. In this study the qualitative phase of data collection completed to date has already provided a rich source of information to inform individual teaching staff about the way students perceive and approach their subject. The qualitative data collected to date has allowed a range

of issues beyond the normal course evaluation to be explored, providing a much richer source of feedback on students' experiences of the teaching and learning environment. These issues can be further explored in the quantitative stage of the project to investigate whether these views are a valid representation of the whole cohort.

Results

The following section outlines some of the findings from the qualitative phase and also introduces some more general questions arising from analysis of the data which the writers feel deserve further exploration and should be of interest to the wider HE community. NVivo software was used to support the analysis of the qualitative data. The selected findings are presented here as an example of the range of information which can be obtained through use of semi-structured interviews to explore experiences of teaching and learning.

Of particular interest was that the data gathered to date highlighted some issues which would not be uncovered by the course evaluations used at the institution in which this study was based, or through the use of the NSS. Five themes have been drawn from the data to provide examples of this. Data emerged which provided an insight into how students' expectations were related to their perceptions and also how students' approaches were influenced by the perceived teaching quality and the value placed on individual components of study. Data also emerged regarding students' uses of strategies within their learning, such as peer studying and questioning.

Students' expectations

A clear theme emerging from the interviews was that students have very specific expectations as to what staff should do and how they should use their contact time with students. One student quoted that one member of staff was the only one who "actually uses the seminars properly."

Kember and Wong (2000) identified that, when students complete course evaluations, they rate according to their own conceptions of teaching and may therefore poorly rate teachers who use methods differing from those conceptions. Where student

evaluations are used by an institution to evaluate teaching and learning, attention should be given to understanding students' expectations; time should be taken to explore student expectations of how contact time should be used, to discuss how these perceptions are formed, how they differ amongst students and in what ways students are evaluating their course experience against these expectations.

Students' approaches may be affected by the importance of a subject

In exploring students' opinions of the individual modules studied, it was found that students identified their Fluid Mechanics/Thermodynamics subject as being important. For example, "it's so much of the bread and butter of what we want to do as mechanical engineers" and students explained that they made an effort to attend sessions because "…it's an important subject." It is noted that a standard course evaluation would not allow for modules or subjects to be considered in terms of how important they were perceived to be by individuals and with respect to the other aspects of a programme of study.

It is suggested that if approaches to learning and studying are affected by perception, and in this case by "perception of importance", then those individuals involved in designing courses and delivering teaching material should aim to understand students' perceptions of subjects. If students are prioritising "important" modules over others then this may need to be considered in course design. Assumptions regarding student study hours are often made based on module credit size but this concept of "importance" may also need to be considered to explore students' "actual" effort, what share of their time they devote to a subject, and how their view of importance is determined.

Effect of a "good" lecturer on student approaches.

Students discussed a module that they were "happy" with, saying that the lecturer was vital in helping their learning: "I think [Lecturer] is definitely helping, it helps having a good lecturer. Definitely." Another student gave an example from one module: "[Lecturer] is just so enthusiastic and I think it's great…he's got a passion for the subject that's passed on to us."

During this discussion students were asked about studying during their own time, since there is an expectation in higher education that students will carry out independent study. Most students agreed that they had completed some of the tutorial questions (questions provided by the staff to offer directed independent study) but one student said "I have done a couple of questions at home" and when asked if he felt he needed to do those questions to help him learn he said "I think [Lecturer] does more than plenty to get you on with." Jones et al., (1997, p.108) explain that some students entering higher education believe that their "lecturer has all of the knowledge that they require and that their task is to assimilate it directly". This finding possibly suggests that we may need to question whether the high opinion of the lecturer in this case could be counter-productive. If students think that the lecturer "does enough" and that working through only some of the tutorial problems the lecturer sets is enough, are we in some way removing the need to develop self motivation and also the full range of academic skills such as enquiry and information seeking?

When discussing further reading for a subject during the interviews one student stated that they "haven't really needed to [read]". This may also be linked to the perceptions that the students hold regarding the quality of teaching and the quality rating of the lecturer. Do these perceptions encourage the students to think the lecturer will cover enough in their classes to enable them to develop the level of knowledge and understanding required of them at the undergraduate level? A standard evaluation questionnaire may ask about quality of teaching, or about time given to independent study. It would not, however, provide the additional information which has allowed the inferences here to be made.

Use of informal peer study groups within the discipline

During the interviews the theme of how students approached their work was discussed. A standard evaluation questionnaire may explore this, asking for example: "Was the amount of independent study required what you expected?" or "Were you organised in your study?" This study aimed to gather more specific information about how students approached their studies at different times during their course.

When exploring the concept of independent study in interviews it became apparent that students appear to have established informal peer groups for studying in their own time.

One student confirmed "I had ad-hoc study groups that were in the course, a few of us in our spare time would go and do some questions before a seminar" and another student said "we worked in a big group". This finding suggests that several study groups may exist amongst a cohort of students. Within engineering degrees small groups are often established for lab work, but may not established in fundamental subjects for seminar work or within lectures. Assessed work in these subjects is usually of an individual nature so, under normal course circumstances and standard evaluation practices, teaching staff would be unaware of this informal peer work taking place outside of the class time. These study groups may suggest some students have a mature and focused approach to their studies; selecting to work in groups with others who share common problems, to allow them all to deepen their knowledge within an area. It may be also be that students are pragmatic in their participation in study groups, taking part in those groups in areas where they feel less able, with the aim of gaining support from other students.

Boud (1981, p.14) acknowledges that "students can learn as much, or even more, from their peers as from their teachers, but the help students can give to each other is a severely under-utilised resource in higher education." It would seem reasonable for further investigation to take place to identify the scale to which these study groups exist, and the influence they have on students' approaches to their learning. It may also be interesting to consider the place of these small study groups within the formal system at the University: for example, should participation be acknowledged on submitted work, should participation be encouraged for informal tutorial work, and do those without a study group fail to benefit in some way?

Students' questioning behaviour

When the level of peer working amongst students was explored further during the interviews, a taxonomy of student behaviour with regard to asking questions in lectures became apparent. With respect to evaluating teaching and learning experiences, it is interesting to explore the concept of questioning in much more detail than a standard question, such as "Were there opportunities to discuss questions with staff?" More detail and depth can be gathered through exploring student engagement in questioning. For example: when are students encouraged to ask questions? What type of questions

are students asking? Who do students chose to ask questions too? How has questioning supported/furthered learning?

Throughout the interviews, students appeared to categorise their decisions about when and how to engage in questioning. Table 1 provides a summary of the categories of problems discussed by students and their associated responses. One student explained that if they are unsure of something there is a "set system," stating "You look over your mates shoulder and see if he's got it… If he hasn't got it then... I'd imagine other guys didn't have it as well and then I'll ask." Students considered that they would only ask the lecturer a question if they were unsure about a fundamental point or if their peer also did not understand/have the correct answer. For example, "I would stop the lecturer and ask them to go through it again if it's something fundamental".

Table 1. Categorisation of problems and responses by students.

Category of Problem	Response
Possibly just misheard	Ask peer during the class
Not understood but not fundamental	Not ask question at all, look over work in own time
Procedural problem	Ask peer during break in lecture
Fundamental point not understood	Ask peer first, if they also do not know then ask the lecturer

Biggs (2003, p.1) suggests that we could regard good teaching as "encouraging students to use the higher-order learning processes that 'academic' students use spontaneously". If students' opinions about when they should ask questions are preventing opportunities for discussion in lectures, and the opportunities for students to make use of higher order questioning skills are limited in some way by this, is it possible that in some way the academic behaviour of our students is limited and that "good teaching" as defined by Biggs might not be taking place?

These results suggest that further work should be carried out to explore what students consider to be fundamental points within their learning; if their understanding of what is fundamental is not correct then they may be letting their learning continue without addressing key issues. It would be interesting to explore whether this behaviour is apparent in other classes and to question whether this logic of students deciding what is fundamental is a positive experience; is it constructive that students choose carefully when to ask the lecturer questions or does this hold back some possibly fruitful class

discussions? It could be suggested that how students have engaged in, or been encouraged to make use of, higher level questioning skills should be included more often in the process of evaluation of teaching and learning.

Discussion of results

There seems to be a great deal about student perceptions, and approaches, which is generally not spoken about or not considered during normal teaching and learning evaluations. Students have definite ideas, expectations and opinions about their learning contexts, as well as their own studying and coping/managing strategies. The issues explored in the results raise several questions which now need to be explored through the questionnaire with the larger sample to understand whether these views, practices and approaches are consistent amongst the cohort.

To enable staff in higher education to understand how they are contributing to students' learning, they need to be more aware of students' perceptions and of their actual approaches to learning and studying. Students' perceptions were explored and data emerged showing perceptions of the teaching and learning context, and satisfaction within it, to be linked to expectations. It is suggested that students' perceptions may need further exploration to understand how the value students place on individual components of a course affects their approaches to study. A greater understanding of students' expectations within higher education would also allow perception ratings to be interpreted in ways which are more useful to teaching staff.

This study allowed students' perceptions of lecturing staff to be explored and to consider how these perceptions related to students' approaches to study. It was interesting to note that the value students placed on having "Good lecturers" may have had a negative impact in relation to students developing their own sense of enquiry.

Peer groups were discussed by most students within the study. This provided an example of students' approaches to study which were in some cases quite structured in terms of when peer study would take place. A normal teaching evaluation would not provide the opportunity to explore the extent of peer working within a course. Hence

these findings suggest that evaluations of teaching and learning should consider the extent to which peer work may be influencing students' approaches to studying, their perceptions of the total experience, and their overall learning.

An interesting finding on the theme of students' questioning behaviour emerged in the interviews. This allowed a previously unexplored view to be highlighted. Students explained their logic about how they decide when to ask questions in lectures and suggested that they make conscious decisions about engaging in questioning. Questioning can be considered as a form of discussion or interaction in classes and can encourage students to engage in learning activities and therefore support high quality learning (Chickering & Gamson, 1987). Standard evaluation of teaching and learning experiences may ask students about the opportunities to ask questions and about support given in response to questions. They would not, however, allow the motivation behind questioning to emerge (as it has done here) as an important factor in questioning behaviour.

Implications for using mixed methods in teaching and learning evaluations

This mixed method strategy for evaluation is considered to be of use to those interested in the process of evaluating teaching and learning from a scholarship perspective and from a programme or institutional review perspective. The qualitative stage alone of this strategy has produced findings which are grounded in the local context, and are therefore directly related to local teaching and learning practices. It is considered that these are useful data which can now be used to understand the complexities of teaching and learning from a student perspective.

Standard structured module review questionnaires, by the nature of their design, can ask basic (or generic) questions and allow students to rate experiences. This paper, however, suggests they act only as an introduction to the evaluation of teaching and learning. The data they provide is not rich enough, or in enough depth, to be useful in course design, in determining teaching strategies or, in fact, evaluating the teaching and learning experience as a whole. As teaching and learning is so context bound, the standard evaluations can only ever brush the surface. They cannot ask the questions

which are needed to really understand students' experiences and the decisions students make within their own specific learning contexts.

The mixed method evaluation design allows staff to explore and understand students' views with respect to small elements of study or in whole modules or programmes. It also allows individual modules to be considered in relation to other modules so that differences in perceptions and approaches can be identified. The method allows perceptions to be understood in relation to expectations and provides an opportunity to begin a dialogue to discuss reasonable and realistic expectations with students.

The first stage of this mixed method design allowed an in-depth exploration of learning and teaching from the perspective of a small sample of students. The second stage will allow a questionnaire to be produced, to include items which are relevant to the student cohort and which focus on the key aspects of students' experiences identified in the interviews. Administering the questionnaire to the larger cohort will ensure views are considered other than those of students who self-selected to be interviewed.

The real benefit of this method for practitioners in higher education is that the quantitative data produced following the second stage will be specific enough to be relevant and useful. The qualitative data gathered in the first stage can also be used to help in the interpretation of the quantitative data and to enable inferences to be made.

Conclusion

With limitations in the student time available to gather feedback, mixed methods offer a solution to allow specific and relevant feedback to be obtained without the initial need for full cohort data collection. A small sample of students can be interviewed or can participate in a focus group to allow initial data to be gained before using the data to produce much more targeted and specific larger scale quantitative data collection.

Standard generic module or course evaluations completed by students can only ever give a small amount of information, but great weight is placed upon them within institutional Quality Assurance. The data collected by questionnaires cannot give the full picture of student views and in the eyes of the authors may not be the best source of

data on its own for implementing changes and making decisions to enhance the student experience at an institutional level. As professionals and academics we understand the need for accuracy and high quality information in our own research and we should be aiming to collect information of the highest possible quality so that we can be informed by accurate data and make informed decisions with regard to teaching and learning practice.

The data collected during the first stage of this research lead the authors to consider the role of, and the greater possibilities for, using mixed methods in course evaluations. The paper proposes that these results could not have been gathered using a "standard" class evaluation form and that they may actually be more useful in understanding the wider picture of students' experiences and therefore in informing teaching practice in a more relevant way. Whilst accepting the operational issues of why generic course evaluation forms are used, this mixed method data collection and analysis process has identified some valid issues, student practices, and perceptions, which would not normally have been seen.

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APPENDIX B

Tudor, Jenna, Penlington, Roger and McDowell, Liz (2010), Perceptions and their influences on approaches to learning. Engineering Education: Journal of the Higher Education Academy Engineering Subject Centre, 5 (2). pp. 69-79. ISSN 1750-0052

Perceptions and their influences on approaches to learning

Jenna Tudor, Roger Penlington and Liz McDowell

Abstract

This paper aims to highlight the importance of considering students' perceptions of and approaches to undergraduate engineering education. Whilst considering techniques to maximise the retention of engineering students, it is also posited that understanding how students perceive their learning contexts at university is vital. It is also essential that we understand how these perceptions influence students' approaches to their studies.

This paper builds on existing research which takes a discipline focus to a discussion of the relationships linking quality of learning with generic research into approaches and perceptions of teaching and learning. It discusses an ongoing research project which is making use of a mixed methods research platform to investigate the complex nature of students' perceptions and approaches. It is presented as a valuable methodology for adoption by engineering education researchers.

The research is based on an exploratory sequential mixed methods design where the qualitative data is dominant. Initial analysis of the data collected during the pilot phase, supported by relevant literature, has been used to identify areas of the learning context which appear to influence students' approaches to the engineering modules involved in the study. Some of the emerging themes are discussed in this paper with consideration for the impact on the teaching of engineering.

Introduction

Engineering today is more than an academic or technical discipline. The engineering professions have to deal with 'scientific and technological matters, but increasingly also with economical and political matters as well as with ethical, societal and environmental aspects' (Maffioli and Augusti, 2003). Engineers today need to be able to work in ever-changing technological, social and working environments and therefore must be educated with this in mind. This overview of the engineering profession shows that a great mix of skills is required in the workplace and that the education of today's engineers must reflect this.

As indicated by Jesiek et al. (2009), 'engineering education research is a relatively new field of activity.' The engineering education research community, whilst consisting of a large number of practitioners in teaching engineering, is primarily concerned with the 'field of engineering education research, not the practice of educating engineers' (Borrego et al., 2009). However, as the primary focus of the research is to understand the engineering education process it therefore cannot be considered in isolation from the practice of teaching and learning and the students involved.

In engineering education research the concept of the *context of teaching and learning*, where context is defined as 'the circumstances that form the setting for an event, statement, or idea' (Oxford Dictionary, 2010), is one which must be addressed. The complex nature of education means that no aspect can be considered in isolation; investigations in engineering education must consider the whole context. Tessmer and Richey (1997) explain that 'context is not the additive influence of discrete entities but rather the simultaneous interaction of a number of mutually influential factors.' They discuss how contextual elements can be engineered to facilitate learning and performance and how in this sense 'context is an element that surrounds its members as a continuous presence.'

Aim of the research

This paper aims to highlight the importance of considering students' perceptions of and approaches to undergraduate mechanical engineering education. Whilst considering

course delivery techniques for engineering students, it is also posited that understanding how students perceive their learning contexts at university is vital. It is essential that we understand how these perceptions influence students' approaches to their studies. The paper builds on existing research which considers the relationships linking quality of learning with approaches to and perceptions of teaching and learning.

This paper discusses an ongoing research project which is making use of a *mixed methods* research methodology to investigate the complex nature of students' perceptions and approaches within engineering. It is presented here that mixed methods research is a valuable methodology for engineering education researchers to adopt.

Reasons for considering students' perception

This work examines student perceptions and approaches to learning at an intermediate stage of their course, an aspect which is reported far less than early stages of courses (for example, studies of perceptions at recruitment and their influence on early stage retention and learner identity).

Recruitment

Akam (2003) discusses the major decline, in most developed countries, of young people taking up science, engineering and technology subjects in later stages of education and refers to a public poll from some years ago which 'found Britain's best known 'engineer' was Kevin Webster, the car mechanic from *Coronation Street*'. With views like this it is not surprising that young people do not consider careers in engineering. More accurate public perceptions of engineering (including young people, teachers and parents) must be fostered and encouraged so that they 'match the reality of a multi-skilled, dynamic and challenging profession that is vital to the UK economy.'

The *Progress* project (2004) again recognises the importance of students' perception in recruiting to engineering: 'Given the image of engineering, particularly in Britain, it is hardly surprising that students' own expectations of their courses often differ significantly from reality.' The project confirmed that many people do view engineering as highly analytical and recognise the amount of hard work that is required, however they conclude that 'most people with this perception do not apply to study it.'

The issue of perception affecting recruitment is also significant in the US, where the need for engineering talent is said to be continuing to grow yet enrolment figures continue to decline (Loshbaugh and Claar, 2007). If we can understand how students perceive the teaching and learning environment and approach their studies then universities can consider making adjustments to encourage more students to enrol in engineering courses.

Retention

Retention of both full-time and part-time students in science, applied technology, engineering and mathematical courses is lower than in other subjects (Committee of Public Accounts, 2008). Research has indicated that students are more likely to continue with higher education if they are engaged in their studies and have developed networks and relationships with their fellow students (Crosling et al., 2007). In aiming to increase student retention, being aware of students' perceptions could be crucial.

There is significant research evidence that learning and teaching environments are highly influential on student retention and success. Jones (2008) identified that finance is important to students, but that relations with staff can be much more influential in students' decisions to remain in higher education. If we can understand how students perceive issues such as relationships with staff then we can act to support them in continuing their education.

The reasons for students' non-completion of courses in all disciplines have been explored in the National Audit Office report (2007). Commonly cited reasons for withdrawal are reported to be: 'personal reasons, lack of integration, dissatisfaction with course/institution, lack of preparedness, wrong choice of course, financial reasons and to take up a more attractive opportunity'. University staff engagement with students and discussions regarding their perception of their learning contexts and experiences could provide crucial insight into students who feel that they may have reasons to withdraw. Early identification of issues such as perception of difficulty, isolation and incorrect choice of course can allow universities to act swiftly to support students with their continued study.

A key issue which affects retention and recruitment is that of inappropriate course choice. Hammoudeh (2003) reports that across all universities inappropriate course selection is one of the most commonly given causes for early student withdrawal. As Moore et al. (2007) identify 'First year engineering students often lack comprehensive knowledge of the engineering field. This makes it difficult for them to appreciate why learning fundamentals is required.' Understanding students' perceptions of engineering and their expectations of the course could help significantly with recruiting them to and helping them continue with engineering courses.

Identity

Students can benefit from developing an identity with a programme or a profession during their studies. Through students' construction of their professional identities they 'learn to situate their own knowledge, interests, and sense of self within the larger context of professional engineering' (Eliot et al., 2008). Construction of a professional identity can be a powerful influence upon student retention in engineering programmes, their learning and subsequent adjustment to the workplace. Understanding how students perceive themselves in terms of fitting into an engineering community and their learning within a professional context can allow universities to provide support to students in making the transition and developing professional identities.

Foor and others suggest that factors such as gender, ethnicity and socio-economic status can provide challenges for students' in seeing themselves as part of an engineering community (as cited in Eliot et al., 2008). Being aware of students' perceptions of identity, and the factors causing barriers to them developing professional engineering identities, should be investigated within higher education settings so that strategies can be employed to help develop their professional identities.

Learning

Ellis et al. (2008) explain that the activities undertaken by students which result in learning can be affected by pre-existing beliefs about the demands of a course's assessment regime, or the standards expected by a teacher, or by what students perceive it is possible to learn in a specific situation. Cronje and Coll (2008) explored student perceptions of engineering and science based subjects within higher education. It was found that students expressed a need for 'well organised and planned lectures', seemed to favour 'having a variety of teaching approaches' and preferred teachers who could 'relate theory to practice.' Some students also preferred 'to have most materials available online for ease of reference during assignments'.

Research has shown that students' approaches to learning are related to the quality of their learning outcomes (Ellis et al., 2008). Prosser and Trigwell (2001) suggest that students who adopt a surface approach to learning are more likely to achieve low quality learning outcomes in contrast to those who adopt deep approaches, who are likely to attain higher quality learning outcomes. In this research higher quality learning is considered through Entwistle's (2008) definition that 'high quality learning depends not just on pass or completion rates, but on the nature of the knowledge, skills and conceptual understanding that students have acquired during their degree course.' Laird et al., (2008) report that surface learning does tend to dominate in engineering.

Ellis et al. (2008) discuss the work of Goodyear et al. (2005) and Struyven et al. (2006) who also concluded that how students interpret and experience a course is more important than the course's underlying pedagogical intentions. If students sense that a course is badly implemented, that they are overloaded with work, that there are no clear goals or feedback is poor, then they are more likely to respond with surface rather than deep approaches irrespective of the pedagogy or the technology being deployed by the teacher. Entwistle (2008) carried out teaching and learning research in higher education level electrical engineering and concluded that 'it is not so much the teaching-learning environment we provide that affects the learning approaches of individual learners, as their perceptions of it.'

Figure 1 shows a theoretical framework for this research. The five areas identified under *context* appear in several sources of literature as factors (some of which are discussed above) which affect students' approaches to learning. As this research continues, a more detailed theoretical framework will be developed, showing specifically the issues relevant to the engineering students involved in this project.

Methodology

This research is influenced by the pragmatic paradigm in which knowledge claims arise out of 'actions, situations, and consequences' and where 'instead of methods being important, the problem is most important, and researchers use all approaches to understand the problem' (Creswell, 2003). Borrego et al. (2009) explain how they 'expect that quantitative, qualitative, and mixed approaches will be essential in the future' in engineering education research. Bailie and Bernhard (2009) agree that it is 'necessary in educational research and in engineering to use quantitative as well as qualitative approaches.'

A *mixed methods* approach to data collection and analysis is being used in this project to enable data to be gathered on the current contexts surrounding student learning experiences, and to determine what factors students perceive as being important to them. The core assumption which forms the basis of the mixed methods research approach to enquiry is defined by Creswell and Garrett (2008): 'When researchers bring together both quantitative and qualitative research, the strengths of both approaches are combined, leading, it can be assumed, to a better understanding of research problems than either approach alone.' The theoretical framework in Figure 1 shows the varied aspects of students' learning experiences which affect their perceptions and approaches to learning. The methodology has therefore been developed to allow the different elements of those factors affecting students to be fully explored. The use of this methodology will be evaluated once all data has been collected and analysed.

The research involves two phases of data collection, using an exploratory sequential mixed method strategy with data analysis between stages. Figure 2 shows the mixed methods notation of an exploratory sequential design. The notation of 'QUAL' is used to represent the dominant qualitative source and 'quan' to show the less dominant quantitative source used for validation purposes. The method chosen first allows qualitative data to be gathered from a select sample on the current contexts surrounding student learning experiences, and then a quantitative data to be gathered from a larger sample to validate the results. This practice of using unequal sample sizes, where one sample has a greater weighting placed upon it, is normal within mixed method studies (Morse, 1991).

The research data is drawn from a Mechanical Engineering BEng (Hons) degree programme at a post-92 university. The study involves data collection over two academic years, using student volunteers in their second year of study. The reason for collecting qualitative data initially is that there is little known about students' perceptions of mechanical engineering. The initial qualitative stage therefore allows for data to be gathered, analysed and then used to produce a taxonomy which can be

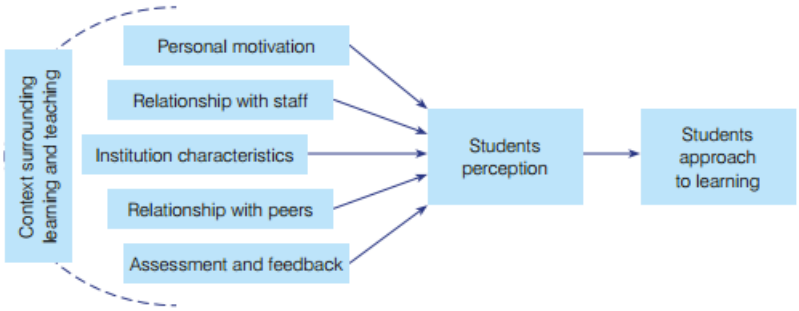

Figure 1. Theoretical framework for considering students' perceptions and approaches to learning

Figure 2. Exploratory sequential design (overview) (Creswell, 2003)

investigated further within the larger quantitative aspect of the study. Data is gathered through observations, semi-structured interviews and questionnaires. Both stages of the research will follow the process demonstrated in Figure 3.

Data collection

Sampling for the interviews makes use of stratified sampling to ensure that data is collected from part-time and full-time students and is representative of the population (Creswell and Clark, 2008). Samples for the quantitative data collection, and for qualitative data in observations, will involve all those students from the second year cohort who opt to be involved. The sample sizes when interviewing will therefore be a different size to the other data collection methods used in this project. This method follows the Creswell et al. (2008) example of sampling within mixed methods where unequal sample sizes are used 'in the quantitative and qualitative strands of a study for the purpose of providing a full picture of the situation.' The purpose of the observations was to act as an observer and a non-participant in classes in order to understand how students were behaving in classrooms and to understand the context of the classes to aid discussion in the interview process.

The individual semi-structured interviews took place with students at the start of semester 2 with the aim of exploring their experiences of semester one and informing the design of the quantitative and qualitative questionnaire which was administered at the end of semester 2. The interviews were semi-structured so that a core of questions could be addressed whilst still allowing for flexibility to respond to, and explore further, issues arising during the interview. To date, 16 students have been interviewed, with interviews lasting between 25 and 40 minutes in order to try and keep the time commitment from them to a minimum. The topics addressed in the student interviews were opinions of the modules, approaches towards learning, and institutional factors affecting learning, subject content and assessment.

Before the interviews took place, two informal meetings were held with students (eight part-time and three full-time) during which there was general discussion about experiences of the module. This data was used to inform interview questions, along with the already piloted *shortened experiences of teaching and learning questionnaire* (SETLQ) (ETL-Project, 2005).

Questionnaires with a mix of closed Likert scale questions and open questions were given to the whole student cohort asking them to self-report on which subject areas they find easiest/hardest, to discover which delivery and assessment strategies students felt helped them to understand the material and which factors they felt prevented or hindered their learning. The questions were again informed by the *shortened experiences of teaching and learning questionnaire* (ETL Project, 2005) in addition to the detailed information collected from the student interviews.

Results

The following section outlines some of the findings from the study and introduces some more general questions arising from the student interviews which the writers feel deserve further exploration and should be of interest to engineering education researchers and the wider higher education community. The findings discussed here are relevant to evaluating perceptions of teaching and learning and represent the range of information gained through a mixed methods approach.

Initial analysis of the data collected, supported by relevant literature, has been used to identify the areas of context which appear to influence student learning. The contextual factors which appear to have most heavily influenced student experiences are summarised in Figure 4, which shows that (in addition to those factors outlined in the theoretical framework) the students involved in this project were also influenced by issues such as the 'demands of the subject' and the value placed on 'problem solving' activities. The following section gives more detail of the specific issues that students felt were influencing their learning in this context.

Figure 3. Exploratory sequential design (Creswell and Plano-Clark, 2007)

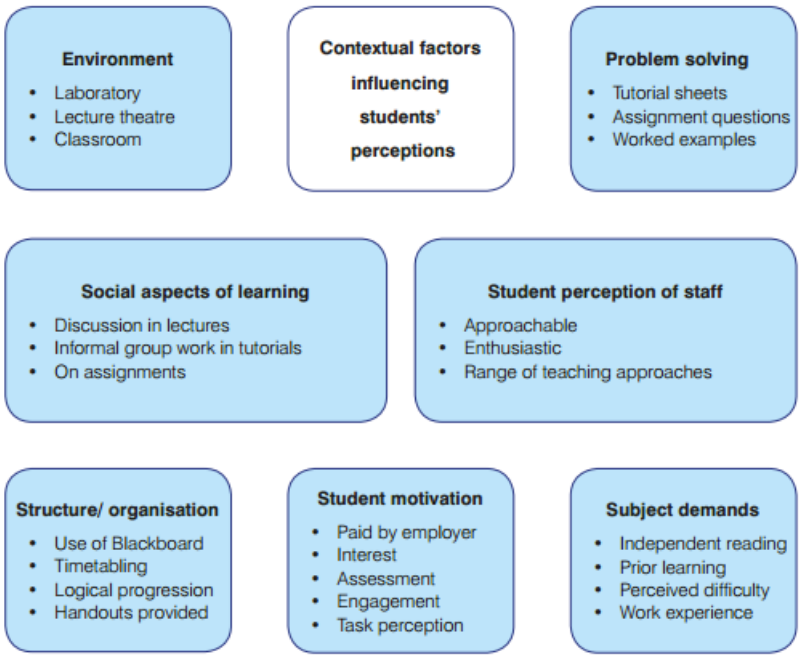

Figure 4. Summary of contextual factors influencing students' perceptions

Use of contact time

A clear theme emerging from the interviews was that students have very specific expectations of what staff should do and how they should use their contact time with students. One student was quoted as saying that one member of staff was the only one who *'actually uses the seminars properly.'* Students value seminars, stating that *'the good point of some of it was the seminars, being able to go in and have a one to one.'*

Students were asked to rank the factors relating to staff use of contact time which they felt have most helped their learning. They ranked having the opportunity to complete worked examples as most helpful, followed by lectures and then being given handouts and lab sessions equally.

Students discussed a module that they were 'happy' with, saying that the lecturer was vital in helping their learning: *'I think L is definitely helping, it helps having a good lecturer. Definitely.'* Another student stated: *'I do think the lecturer makes a big difference and the way he approaches the subject'*, giving an example from one module: *'L is just so enthusiastic and I think it's great […] he's got a passion for the subject that's passed on to us.'*

Importance of a subject

In the classroom observations, and confirmed through the questionnaire, it was found that about 90% of the cohort regularly attended the sessions in Energy Studies. In exploring this during interviews it was found that students regard the subject as important, for example: *'it's so much of the bread and butter of what we want to do as mechanical engineers'* and *'that's because it's an important subject and also because the delivery is a lot better than other modules.'*

Students did acknowledge that subjects do, however, have to have personal relevance to them to be considered important: *'So it's a case of relevance to that person, what they might be doing in the future.'* Several students felt that the core subjects were important and defined these as being Energy, Mechanics and Maths, and as one student explained: *'to become an engineer you have to prove you can do this* [set of subjects]' and the other subjects studied are *'to make you a better engineer.'*

All agreed that they wanted to do well in the core subjects: *'The subjects I'm going to pay most attention to again are the core subjects* […] *I want to do well* [in the core ones] *just mainly because if I can get through them, then I know I'll certainly be able to get through the others.'*

Lecturer support

Students did however acknowledge that there were sometimes difficulties in getting individual support from staff, stating that *'some of the lecturers didn't reply to emails.'* This is interesting to consider: in a world where most students are technically proficient and choose email as a convenient and preferred form of contact, we may need to consider how *staff* view its use. Should there be standards or systems set up to ensure all students receive prompt responses? Part-time students found it difficult to see staff in person and they felt further use of email would help them receive help when they were back in their workplace: '[some lecturers would say] *"Look, if you've got a problem then you need to come and see us" and it was kind of around dinnertime and you're having a full day of work and you need a break or you just don't concentrate in the afternoon. I found that a bit difficult as well. It would have been nice to just get a bit of feedback over the emails or internet or somewhere.'*

Other students valued staff that were able to respond to them despite what they acknowledged to be busy working conditions, giving the example of one member of staff: *'I'm sure* [the lecturer] *had people bombarding them with questions and* [the lecturer] *actioned it* […] [the lecturer] *didn't forget to do something that they promised to do, which I think has more of an impact, you know, there's reliability.'*

Assessments

In the semi-structured interviews, students discussed their experience of both closed and open book class tests and how they did not find the class tests as useful as coursework style assignments in terms of helping them learn. Students admitted that in their first year they had crammed and just aimed to pass the class tests, whereas the completion of assignments in the second year had forced them to try to understand the material. On a positive note, one student extolled the benefits of the feedback he received following a lab assignment :*'Actually, the first feedback I got from* [the lecturer], *and I used it for the rest of them, and I ended up getting 95% for the rest of them, so I would say it did me good.'*

Structure

That modules had clear teaching and assessment structures seemed to be important to most students, and in cases where the structure wasn't clear students acknowledged that they did not see the point in the module. In one case students were given a multiple choice test which they viewed to be 'too easy' and explained that the *'multiple choice ones we did* […] *I didn't particularly like them because it just seemed a bit pointless really.'* In another case, students were unclear about weekly assessed work they were completing: *'he gives us an assignment every week as well. So he gives us two or three questions a week that we've got to do and hand in and then he marks them. And apparently that's going to the grades.'* Students do, however, acknowledge that while lessons can be 'good' and 'fun' it doesn't mean they understand the reasons for learning that subject: *'It was fun and I liked it but I didn't see the point in it* […] *and then it wasn't really that organised as much as, say* [other subject] [...] *It was just basic, that's about it, and I didn't really see the point in it to be honest.'* The comment that a topic or subject was 'basic' was made by several students, showing how important it can be to teach at the appropriate level and to manage expectations by explaining why certain material is being covered in a particular way.

It would be interesting to further explore the effect of unclear structure. For example, it would be fascinating to see what approach to learning was taken in the module where a student commented that: *'I don't know how the assessment worked. I think you winged it really.'* One student, who had industrial experience, recognised the need for structure and questioned in one case why there wasn't quality control to ensure all classes were structured. Again, communicating and discussing structure with students could be important in cases such as this.

Staff consistency, reliability and professionalism

Students have expectations about how staff should behave and act. One student felt that *'lecturers, have to have a sort of higher standard, professional attitude which is fair enough because other people are here to try and get a career.'*

Students indicated that they didn't mind arrangements changing as long as they could see the benefit to themselves and that changes were done in advance: *'I think originally we had one one-hour lecture on a Wednesday, which was, I think it was 11 until 12 or something, which seemed a bit pointless'. 'I think that was shoved onto the Friday morning or something, which worked out a lot better, having the whole day off.'* Students were unhappy when things were changed with little notice: *'I remember coming in a few times and no one being there and stuff like that and them being cancelled, or you got an email in the morning saying it was cancelled, but then you don't sometimes check your emails in the morning.'*

Students had all used the electronic learning platform (eLP) at some point throughout their first year, although not all used it regularly. One student felt quite strongly that staff should adhere to the minimum standards set out by the institution, saying *'I don't like the lecturers that don't put anything on it because I just feel that you should do really. At least then it's there.'* Several students explained that although they were happy to use the eLP they did not feel that it was appropriate to be referred to lecturers' personal web pages. They seemed to prefer the professionalism and formality of the eLP (even after acknowledgement that the eLP had difficulties of its own, such as negotiation) rather than personal web pages where hobbies or holidays etc may be discussed alongside pages discussing engineering theory. One student gave an example of this: *'He put links to his own family web pages on there.* [Laughter]. *And that was completely pointless, a waste of my time; although I looked at it, which is even worse!'*

Benefit of peer learning

During the interviews the theme of how students approach their work (in terms of assessed work, individual study and completion of tutorial problem sheets) was discussed. There is an expectation amongst many teaching staff that students will carry out independent study in addition to completing classroom tasks and assessed work. For example, this is often assumed to be done through directed reading or encouraged through the completion of a tutorial sheet which is generally a series of questions related to specific topics of study. These tutorial sheets can then be discussed in tutorial sessions and students can obtain feedback on their progress in a topic or identify any areas causing them difficulty. This line of questioning revealed that students appear to have established informal peer groups for studying in their own time, for example, one student confirmed: *'I had ad-hoc study groups that were in the course, a few of us in our spare time would go and do some questions before a seminar'* and another student said: *'we worked in a big group.'*

Within engineering degrees, small peer groups are often established in fundamental engineering subjects for lab work but not necessarily established for seminar work or assignments. Assessed work in these subjects is usually of an individual nature, so under normal course circumstances teaching staff would be unaware of this informal peer work taking place outside of the class time.

Observations in the class also saw that peer networks were present in the classroom, with small groups of two, three or four occasionally discussing problems during the session, but more often during breaks in teaching. Students also explained that when they have been busy they use technology to allow them to work with their peers: *'But sometimes when I've been busy, I just do it from home and it's text messaging, mobile, you know, scanning bits of work in* […] *So it's done in various ways. But there's generally a shared kind of ethic there, I suppose; we share everything. I certainly wouldn't have managed to do things if that wasn't an option. It's definitely a better way of working.'*

Discussion

It can be seen from the literature discussed here that students' perceptions contribute widely to their experiences in higher education.

From the quotes provided it can be seen that students' perceptions are linked closely with their expectations. It may be that, with respect to encouraging students' engagement with their learning in favour of deep approaches to learning, we should be discussing students' expectations more. Being better aware of students expectations throughout a programme may help us better understand their perceptions and subsequent approaches to learning.

In discussing with students the aspects of the teaching and learning context which have influenced them the following topics were raised:

- assessments
- structured delivery
- organisation of timetables and lecturer
- staff use of contact time
- interactions with staff
- personal relevance and importance of a subject
- peer learning.

The issues raised by the research are ones which are generally considered when addressing the student experience. Considering these same issues now with respect to students' expectations/perceptions and their approaches to learning may provide data far richer in quality and lead to a more useful understanding of the student experience in terms of 'learning and teaching'. Consideration of students' perceptions and approaches could be integrated with work focusing on improving the student experience. As research by Entwistle (2008) shows, students' perception of context affects the approaches they take to learning and therefore the subsequent quality of the learning achieved (Ellis et al., 2008). It is suggested that the contextual factors which score low on instruments such as the National Student Survey should be considered in terms of 'teaching and learning'. These factors should be addressed in a way which will enable students to perceive their learning contexts in a more positive manner, therefore improving their experience and simultaneously encouraging deep approaches to learning.

As the study progresses further there will be another round of interviews before the quantitative instrument is developed. During this time the following points from the research data will be explored:

Importance

- Does students' 'importance ranking' of a subject change throughout a year of study? Does this affect the approach towards learning in that subject?
- Why do students perceive the Energy Studies module as an important subject? How do students determine the importance of a subject? Is it connected to personal relevance or implicit information passed on through institutional structures such as timetabling and modularisation?
- Does the delivery style of a module (e.g. traditional lectures, informal group work) affect students' perception of the importance of a module?

Assessment

- What impact have different forms of assessment had on students' approach to learning? Staff should make an effort to explore the effect that different assessment methods have on their students, looking not just at the marks obtained but actually how different students have responded to their assessments (time spent, approach taken, etc.) and how they have perceived them in terms of developing their own learning.

Contact time/staff support

- Students value contact with staff but, as this is currently under pressure, other delivery modes are being used throughout higher education institutions which may not provide the same learning experiences as face-to-face contact. For the newer technologies and alternative delivery modes to be used effectively they need to be thoroughly supported. The difficulty is that these new delivery methods need academic development time to ensure they are implemented in a structured way from which students will see real benefit. This creates a large time overhead and becomes difficult for academics to initiate and there is therefore a risk that much valued contact hours are being replaced by poorly implemented technology for which academics are ill-prepared, leading to the eventual dissatisfaction of students. It would be interesting to explore what would happen if these technologies were removed and their associated cost saved so that more time could be given to student/staff dialogue. This could allow academics further opportunity to be aware of, and respond to, students' expectations and perceptions.

Peer learning

- It would seem reasonable for further investigation to take place to identify the scale on which these informal study groups exist and the influence they have on students' approaches to their learning. It may also be interesting to consider the place of these small study groups within the formal system of a university. Some emerging questions are: whether participation in informal study groups should be acknowledged on submitted work; should participation be encouraged for informal tutorial work, and are those who do not work within a study group

disadvantaged in any way? Boud (1981) acknowledges that 'students can learn as much, or even more, from their peers as from their teachers, but the help students can give to each other is a severely under-utilised resource in higher education.'

Conclusion

The research presented here has outlined why we need to better understand our students' perceptions. We have observed the strength of perception in guiding how students approach their learning. We have also observed that perception has a much wider role, influencing the complex nature of the student experience and, in this case, the students' perception of what subjects and behaviours are important to becoming an engineer. It is evident that they have clear expectations and we therefore need to encourage communication between staff and students to allow expectations to be discussed. Through dialogue it will be possible to explore expectations, to discuss how realistic these may be and how they can be met. Communication will also allow any limitations which may render a student's expectations unachievable to be acknowledged. ■

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APPENDIX C

Penlington, Roger, Tudor, Jenna, Joyce, Tom and Thompson, Jamie (2012) Do different learning contexts, processes and environment affect perceptions, dispositions and approaches to learning? In: EE2012: International Conference on Innovation, Practice and Research in Engineering Education, 18-20 September 2012, Coventry University, UK.

GP198/abs050

Do different learning contexts, processes and environment affect perceptions, dispositions and approaches to learning?

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Abstract: *This paper is the initial report of an investigation into students' perception and approaches to learning as an extension to a Mixed Methods study. The initial study developed and applied a quantitative instrument within one institution, this study sought to deepen our knowledge through the deployment of the same instrument within a second institution delivering a mechanical engineering programme under similar circumstances.*

The results obtained through this quantitative stage show that for many questions the institutional context did not impact upon the student views which gives engineering academics a clear indication of where opportunities for enhancement of practice exist in relation to approaches to learning and studying, module and classes, ways of learning, and assessment in addition to student responses to material aspects such as student perceptions of staff and university resources.

The paper details the methodology and quantitative instrument which will enable wider application in further contexts or the employment of the findings within a further and deeper qualitative investigation.

Introduction

This paper reports an ongoing study into the perceptions, dispositions and approaches to learning of undergraduate mechanical engineering students within an English post '92 university which has been extended to investigate the influence of learning context by sampling within an English pre '92 university. Through exploring the relationship between student approaches to learning and the context of learning it is proposed that existing programmes and proposed interventions may be evaluated for potential impact.

The research study has been carried out to determine the approach students take to their learning and also to understand what students perceived to be important to both their learning and to their success in the programme. The initial research was also designed to investigate how students perceived the context which surrounded their learning including: specifics of the curriculum; relationships with staff; classroom environment; teaching delivery; and assessment (McDowell et. al. 2010).

Positive correlations between the quality of outcomes of students' learning and the approaches they take were identified by Svensson (1984) therefore at a time of significant change within Higher Education (HE) in the UK investigating the link between context and students' approaches will become

even more important. It is also reported that students' approaches to learning can change during a programme of study; they are influenced by students' perceptions of their learning environment (Bloxham and Boyd, 2007) and can also be affected by students' expectations within a programme (Harvey and Knight, 1996).

It is suggested that useful indications of effectiveness and quality of teaching, or programme innovations, can therefore be achieved through consideration of what students say they do in a particular context; both in terms of their approach towards their studies (engaging in surface or deep learning approaches) but also in their wider behaviours (motivation, interest, attendance etc.) at particular stages during a course. Therefore this study has extended the earlier work to include a second university, change of locational context, but also change of stage of learning. In this way we are moving towards a situation where the engineering educator may be able to design a task to stimulate the approach taken by our students (Booth 2004).

The study was structured to reduce the influence of as many variables as were possible within the control of the researchers. The student groups making up the sample were all studying in the same city on traditional Mechanical Engineering programmes accredited by the IMechE in cohorts which were of similar size. As one Higher Education Institution (HEI) encourages a year long placement in the third year of the programme the sample groups were level 4 and 5 students.

Methodology

The previous study had established that the experience of mechanical engineering students is an under-researched area with engineering generally being considered at a broad discipline whereas this study sought a finer discrimination in outcome as anecdotal evidence from staff teaching across sub-disciplines suggests that students of the different engineering sub-disciplines approach their study differently. Therefore to allow themes to be identified which would allow the work to be explored within the existing framework of scholarly work in approaches and perspectives of learning the study adopted a Mixed Methods exploratory sequential design (Tudor et. al. 2012).

The outcomes of the qualitative stage of this work identified factors which influenced students' perceptions which allowed a quantitative instrument to be developed and applied within the post '92 institution with a total of 91 questions. The questions used a 5 point likert-type scale to explore the following themes; expectation of HE, approaches to learning and studying as well as personal feelings of experience of classes, assessments, structure and staff.

The outcome of the analysis of the first quantitative survey in the post '92 institution highlighted interesting linkage between the approaches students take and their perception of the learning and teaching environment (Tudor et.al. 2010). It is from this position that the current study was undertaken to explore approaches to learning and teaching within two different contexts, Figure 1.

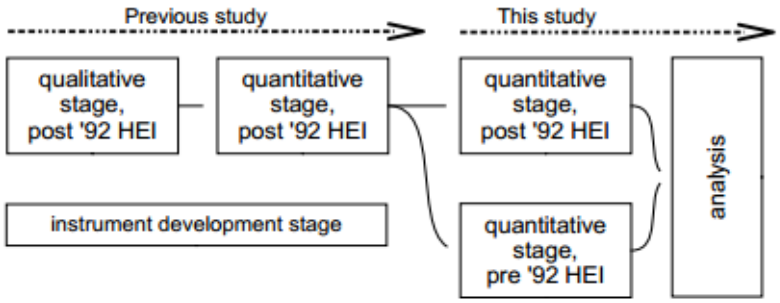

Figure 1, relationship with previous study

For this study the questionnaire from the previous study was reviewed to ensure equal suitability for both HEIs, ensuring terminology etc. were either neutral or matched to context and cohort stage. At this time the opportunity was also taken to reduce the overall question count to 82 (appendix 1).

The questionnaire was deployed to 322 student mechanical engineers at levels 4 and 5 from the two universities, one pre '92 (N=153) one post '92 (N=169), with responses received from very similar proportions of each cohort.

Both programmes follow a traditional structure for mechanical engineering programmes based upon the delivery of a body of knowledge founded in mathematics and engineering science which is contextualised through application in design which incorporates materials, manufacture, business and management. Delivery mechanisms and contact hours although broadly similar are marginally higher in the pre '92 institution and ranged from large lectures through design classes to smaller group laboratory classes, with the assessment strategy of both programmes is based upon examinations for knowledge based content supported by project work for skills development.

The first round of data collection took place two-thirds of the way through the academic year and the second round saw the questionnaire being deployed early in the following academic year. Therefore the level 4 progressing students were sampled again early in their level 5 studies. The results therefore only identified a change in views for the collective cohort in each instance rather than any transition of views for individuals. The questionnaires were deployed as a paper based format to those who had agreed to participate (average of about 65% of the cohorts involved) at the end of a taught lecture session. Data obtained was analysed descriptively using SPSS which allowed the examination of both mean and modal scores by question and by cohort.

Results

An initial overview of the results obtained interestingly suggest that for the majority of questions there was no significant difference between the responses obtained at each institution, the small number of questions which showed significant differences are discussed later. All results, similarities and differences, give a clear focus of the themes which may be followed up by a further qualitative investigation. The results which may inform engineering educators at this stage of the research are those where a clear and uniform response to aligned questions were obtained. These are summarised within themes below:

For the questions, *I hope the things I learn will help me to develop as a person and broaden my horizons* and *I want to learn things which might let me help people, and/or make a difference in the world* under the heading what do you expect to get from the experience of higher education obtained uniform agreement in all cohorts regardless of stage. The clear purpose of study shown in these responses is also reflected in the uniform agreement with the questions, *in making sense of new ideas, I have often related them to practical or real life contexts* and *it has been important for me to see the reasons behind things* that was shown within the theme approaches to learning and studying.

Within the theme module and classes all cohorts were uniformly in agreement that *you have to really understand the subjects to get good marks* but were uniformly in slight agreement with *in some modules I am unsure what I've actually learned* and only in slight agreement with *it was made clear to me what I was supposed to learn in most modules.*

A result within module and classes which may well have been sensitive to context yet received uniform levels of agreement were *space and comfort in lectures affects how much attention I pay in classes* and *I put more effort into modules that seem to be well organised.*

The researchers were interested to explore the peer relationships of the cohort; this was integrated within the ways of learning theme, and did show a small difference between the two HEIs. The question *throughout the year I have chosen to work with others on several occasions* obtained slightly more agreement in all cohorts at one HEI than the other, the same groups were in slightly more disagreement with the question *to protect my marks I am careful how much knowledge I share with and how much I help other students.*

Assessment and particularly feedback has been an area of enquiry within engineering education in recent years due to the evidence that it is an area of discipline based poor performance (Webb and Willis 2010) therefore it was interesting to see when one HEI's cohorts were uniformly uncertain that *the feedback given on assessed work helped me to improve my learning and studying* they were also the most uncertain in responding to the question *it was clear what was expected in the assessed work for the degree course.* Regardless of this contextual difference there was no clear contextual difference in that all students were uncertain in their response to the question *I am unsure of how much I have really learned this year.*

The theme university structure and staff has results of interest for their uniformity and contextual difference. All cohorts were in uniform agreement in response to the questions, *interactions with most staff have been beneficial to my learning* and *unprofessional staff (e.g. poor timekeeping) affect how seriously I work towards a module*. Regarding the question *the workload has been too heavy at times*

for me to really learn one HEI's cohorts were unsure whereas the other HEI's agreed responses which were reflected in the disagreement of the first group with the question *the timetable has made it easy for me to do my own studying around lectures*, whilst those who were unsure about workload felt more confident about working around their timetable.

The final questions were grouped around the theme of personal factors where the clarity of outcome is less clear for many questions yet all agree to the question *second year requires you to be more responsible for your own success than first year* and near uniform agreement with *I am more motivated than in the first year because this year counts towards my final mark.*

A selection of questions where the modal score differs by more than two scale points are shown in Figure 2 without reference to the institution at this stage as the authors consider these to be preliminary results which need to be further explored by qualitative methods.

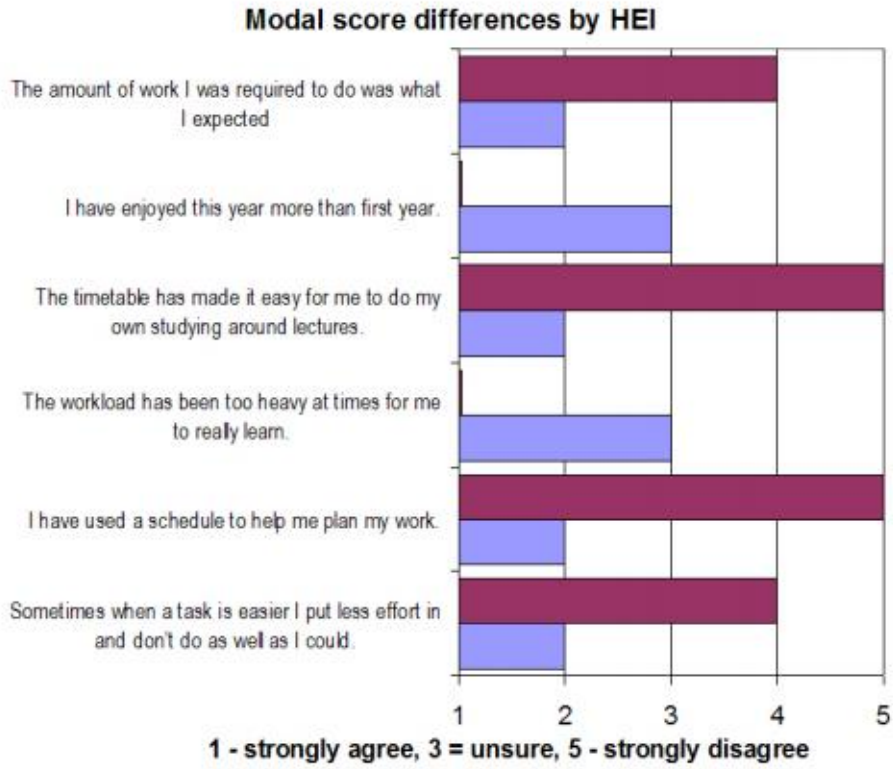

Figure 2. selected question modal scores

Discussion

This study has reported some outcomes of an ongoing study into the perceptions, dispositions and approaches to learning of undergraduate mechanical engineering students within a post '92 university which has been extended to investigate the influence of learning context by sampling within a pre '92 university. As the record of a quantitative stage in a Mixed Methods study it presents these results as a preliminary record of the work and therefore takes care in the conclusions drawn. To derive the fullest insight possible with this methodology a further qualitative stage of the investigation will be undertaken to explore the student views obtained in more depth. The results reported here are at a preliminary stage but it is still possible to make some preliminary observations which show both strengths and causes for concern within engineering education.

The expectation of broadening perspectives and making a difference in the World are positive indicators of the engagement of all the students with engineering as a profession. This was also supported by students seeking deeper meaning and real-life contexts for their learning. Although this may appear at face value to be a strength within engineering education it may also form a barrier to

attracting students with less clear expectations onto engineering programmes or it may be that this aspect of engineering education is not well exhibited to potential applicants as it is known that engineering programmes are more likely to address their gender imbalance when social and environmental aspects are more explicitly studied (Beder 1989).

This level of interest in wishing to see purpose in the learning activities which are delivered supports the use of authenticity within the classroom an aspect which requires further investigation through qualitative means but does support the level of commitment seen when students undertake design-make-test style exercises. This further investigation could not only explore mechanisms for authenticity but also how the industrial context may be integrated into the delivery of fundamental engineering science at an introductory level as an aid to retention through greater meaning in early parts of the programme.

Within the assessment theme, although the outcome needs further investigation, there was a clear agreement in questions relating to students' taking a strategic approach to their work, *I often use formulas without trying to understand the theory* and *during the year my independent study mostly focussed on what was assessed.* These statements when taken with the concerns raised about effective feedback mechanisms and knowing what has been learned suggest that further work needs to be done in developing practice in the design of assessment, (McDowell 2008) in formative assessment and assessment for learning (Havnes and McDowell 2008).

An important aspect of both learning and assessment are the peer interactions that take place within the cohort both formally and informally. This research suggests that students' are becoming more aware of their own approaches to learning, individually and as a cohort agreeing to the question *I have made a conscious decision about the type of student I am* and *I like to be taught in small steps building up to a bigger picture.* This awareness within the cohort may be constructively developed with the observations above regarding formative assessment and integrating it with individual and peer learning styles (Marshall and Case 2005) when considered as part of a greater programme of change in the nature of mechanical engineering programmes (Royal Academy of Engineering 2012).

Whilst investigating students' approaches to learning the institutions' approaches to teaching are laid open to consideration of effectiveness, such as; the negative impact of staff seen as disorganised, timetables and heavy workloads limiting opportunities for peer working and the comfort and availability of learning spaces. With the current transition of funding, from state to student the need to understand student expectations and their perceptions of their experience will be the subject of much discussion and staff development activity.

Conclusions

This study has initiated an investigation into the influence of context, process and environment within two mechanical engineering degree programmes, a further qualitative stage is expected to yield how the overall themes, context, process and environment have individually or in combination led to the outcomes presented here. The authors recognise that broad agreement expressed after this quantitative stage may have been derived from a differing combination of these themes, this may be particularly the case where larger modal score differences occur, hence the reservation of identifying pre or post '92 institutions in these results.

Following a final qualitative stage and consideration of the results further work may be considered, as this is a study of perceptions, dispositions and approaches to learning in combination their individual influences upon the students' learning have not been considered. For the outcome of engineering education to be most beneficial to students and employers dispositions and approaches to learning may be of greater value than the perceptions of learning which are measured by satisfaction surveys and should therefore be more fully explored to support innovation in academic practice.

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Acknowledgements

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Appendix 1

	What do you expect to get from the experience of higher education?
1	I hope the things I learn will help me to develop as a person and broaden my horizons.
2	I'm focused on the opportunities here for an active social life and/or sport.
3	I want to learn things which might let me help people, and/or make a difference in the world.
4	I want to study mechanical engineering in depth by being involved in a range of interesting modules.
5	I mainly need an engineering degree to enable me to get the job I want.
6	When I look back, I sometimes wonder why I ever decided to come here.
	Approaches to learning and studying
7	I have generally put a lot of effort into my studying.
8	Much of what I've learned seems no more than lots of unrelated bits and pieces in my mind.
9	In making sense of new ideas, I have often related them to practical or real life contexts.
10	On the whole, I've been quite systematic and organised in my studying.
11	It has been important for me to see the reasons behind things.
12	I've tended to take what we've been taught at face value without questioning it much.
13	Concentration has not usually been a problem for me, unless I've been really tired.
14	I've just been going through the motions of studying without seeing where I'm going.
15	If I've not understood things well enough when studying, I've tried a different approach.
	Modules & Classes

16 In some modules I am unsure what I've actually learned.
17 I have done less independent study for some modules than others.
18 I choose carefully which time-tabled sessions to attend based upon what I expect to get out of them.
19 Some modules are more difficult than others.
20 It was clear to me what I was supposed to learn in most modules.
21 You have to really understand the subjects to get good marks.
22 Space and comfort in lectures affects how much attention I pay to classes.
23 Lectures and tutorials are taught and organised in line with my expectations.
24 I would need to have a significant problem that was affecting my learning before I would ask a question in a lecture.
25 I do not think it is appropriate to take up time in lectures asking questions
26 I put more effort in to modules that seem to be organised well.
27 Without handouts and/or worked examples it is difficult to understand what I'm learning.
28 The lectures we were given helped me to understand the subjects.

Ways of Learning

29 I like to be taught subjects in small steps building up to a bigger picture.
30 I do less independent study for modules that aren't important to me.
31 Throughout this year I have chosen to work with others on several occasions.
32 To protect my marks I am careful how much knowledge I share with and how much I help other students.
33 I've put more hours into my weekly studying than I expected before coming to university
34 Before coming to university I needed to ask my friends more about how to tackle work.
35 Sometimes when a task is easier I put less effort in and don't do as well as I could.
36 If I am finding something difficult in classes my first response is to ask other students.
37 I need time working on my own to really learn something.
38 I have done more independent study for some modules than other modules.
39 Talking with other students helped develop my understanding.

Assessments

40 During the year my independent study mostly focussed on what was assessed.
41 I often use formulas without trying to understand the theory.
42 At least once this year I have left work until near the deadline and had to ask other students for help.
43 I have used a schedule to help me plan my work.
44 My marks so far are reflecting my effort and my learning.
45 For tests I like to prepare on my own.
46 I often discuss work with others who are at a similar academic level as me.
47 I plan to concentrate mostly on one or two modules for the exams.
48 The class material has been enough to help me do most assessed work.
49 I am leaving tutorial/homework problems until the end of the year so I can use them for revision.
50 It was clear what was expected in the assessed work for the degree course.
51 The feedback given on assessed work helped me to improve my learning and studying.
52 There are some modules that I'm aiming to just pass rather than really understand.
53 I am unsure of how much I have really learned this year.
54 I am going to be tactical in choosing what to prepare for some exams.

University Structure and Staff

55 I put less effort into modules when I don't think the lecturer teaches well.

56 Unprofessional staff (e.g. poor timekeeping) affect how seriously I work towards a module.
57 Interactions with most staff have been beneficial to my learning.
58 I have needed the same or less direction from staff than in my previous study.
59 I find it difficult to find time to ask staff all the questions I have.
60 The workload has been too heavy at times for me to really learn.
61 The timetable has made it easy for me to do my own studying around lectures.
62 Access to rooms and resources has helped me learn.
63 It hinders my learning when staff refer me to a book instead of giving me the answer.
64 The quality of some teaching hasn't been what I expected.
65 If teaching isn't ideal I ensure I understand the material by doing independent study.

Personal

66 University requires you to be more responsible for your own success than my previous study.
67 I have made a conscious decision about the type of student I am.
68 I am more confident in my own ability than before university.
69 I have enjoyed this year.
70 I enjoy high workloads and difficult tasks as a chance to prove myself.
71 When I feel like I've learned a lot it doesn't always show in my marks.
72 I will be more motivated when my marks count towards my final degree.
73 Personal factors have had more negative affects on my learning that anything at University.
74 If there are small things I am unsure of I wait until I revise for exams to try and understand them.
75 I think some modules are more important than others.
76 I am motivated by a fear of failing.
77 I have found it difficult to maintain a constant motivation & effort through the year.
78 The subject material is much more difficult than I expected before university.
79 I often write extra notes during classes to help me learn.
80 I am rarely satisfied that my work is as good as it could be.
81 The amount of work I was required to do was what I expected.
82 I have found most of what I learned in this degree course really interesting.

Copyright statement

APPENDIX D

List of additional publications which reflect the authors research contribution to engineering education:

Penlington, Roger and Tudor, Jenna (2009) *Dual use of feedback – formative and evaluative.* In: SEFI 2009: 37th Annual Conference, 1-4 July 2009, Rotterdam, The Netherlands.

Gill Davison, Kerry Harman, Jessie Hou and Jenna Tudor (2009) *Assessment for Learning in Practice: case studies from Northumbria's CETL.* Northumbria Conference, Northumbria University, 8 September 2009, Newcastle, UK

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Smailes, Joanne, Lejk, Emma, Beautyman, Wendy and Tudor, Jenna (2012). "Learning the ropes" through a new approach to mentoring. In: 9th ALDinHE Conference "Learning Development in a digital age", 2-4 April 2012, University of Leeds.

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APPENDIX E

The Broader Workings of the Programme

To help explain the context of this research further some key aspects of the teaching and learning context as it was at the time of this research are outlined in the following section.

Teaching methods:

Students will experience a range of teaching styles and methods during their time at the university. Lecturers are free to make use of teaching styles to suit the material delivered, their own personalities and abilities. Lecturers are able to use distributed materials such as (including via Blackboard), specified texts, OHP slides, projected material via a PC, and to teach using techniques including lab-based teaching with appropriate software and traditional 'chalk and talk' methods.

Physical environment/Resources:

A combination of lecture theatres and flat teaching rooms are available however due to the number of students normally in a lecture session lecture theatres tend to be used for most lectures. Open access workspace is provided for students within the department, some which opens until 9pm, and another facility which is 24 hours access on recognition of an ID card and the card reader. Within the library there is discussion space, quiet floors, and bookable rooms to allow for quiet study or space for group work.

Timetabling/Structure:

Timetabling is done through the central university team following discussion about the programme requirements with the programme leader. They are all issued with a personal timetable during their induction/enrolment week. This is also one available online so students can access it from off campus.

Students will not have timetabled sessions on a Wednesday afternoon to allow for sporting activities. In addition the timetable is usually structured so that students will have one day where they do not have any classes, this provides scheduled time where they can work on independent study such as seminar tasks or assessment material.

Assessment:

The programme is structured so that there will be multiple learning opportunities for students to meet learning outcomes (built in redundancy), so that if a learning outcome is not met in one module, it can be met by a student in another module.

The intention of the School Management Team is that the issuing of an assignment schedule is to allow students to manage their time and also to ensure that staff do not bunch up tasks. Deadlines for assessment are suggested by the module teams and then

the programme leader will look at an overview for each year to ensure there is no assignment bunching.

Effort has recently gone into further standardising assessment size, so that 10 credits worth of work in one module is not vastly different to 10 credits work in another module. This has been led by the School management. In the academic years discussed in this research this activity had not been fully rolled out so there was still some level of inconsistency between assignment tasks.

Assessment tasks tend to be split within modules for example 70% exam and 30% coursework or 80% exam and 20% coursework. In cases where modules are 100% coursework or portfolio based there are usually at least two submissions, allowing students to receive feedback on the first before completing the subsequent tasks. In addition to summative assessments all modules should have some formative assessments to allow for formative feedback so that students can judge progress, reflect on their own learning, and take steps to move their learning forward. Assessed tasks include closed book exams, design projects, mathematical/numeric based problems, investigations, laboratory reports and assignments consisting of both numeric and descriptive components.

Support structure for students:

Each year of study has a ‘year tutor’ who is often the first port of call for any general student issues and there is also a ‘programme leader’ who students can turn too for support. For each module there is also a ‘module tutor’ who students can contact if they have concerns in one particular module. To support the lecturing team the School office is also set-up as a place where students can go with queries or to ask for support. More formally the University also has central support for example, to offer guidance on financial matters, disability issues or counselling support for more personal or private issues.

BEng (Hons) Mechanical Engineering - Full Time route 10-11

<table>
<tr><th>Year One
Level 4</th><th colspan="2">Year Two
Level 5</th><th>Optional Placement Year</th><th colspan="2">Final Year
Level 6</th></tr>
<tr><td>Introductory Mechanics</td><td colspan="2">Applied Mechanics</td><td rowspan="7">Professional Placement</td><td colspan="2">Advanced Mechanics</td></tr>
<tr><td>Energy and the Environment</td><td colspan="2">Energy Conversion Systems</td><td colspan="2">Energy Management and Efficiency</td></tr>
<tr><td>Design</td><td colspan="2">Computer Modelling and Design</td><td>Option</td><td>Design for Manufacture</td></tr>
<tr><td>Materials and Manufacture</td><td colspan="2">Business of Manufacture</td><td colspan="2">Materials Failure</td></tr>
<tr><td>Engineering Mathematics</td><td colspan="2">Engineering Mathematics</td><td colspan="2" rowspan="2">Investigative Project</td></tr>
<tr><td>Communication, Study, Experimental and Computing</td><td>Professional Engineering Skills</td><td>Instrumentation Electronics and Industrial Control</td></tr>
</table>

BEng (Hons) Mechanical Engineering - Part Time route 10-11

Year One Level 4 - Tuesday	Year Two Level 5 - Tuesday		Year Three Level 5 & 6 - Thursday	Final Year Level 6 - Monday	
Introductory Mechanics	Applied Mechanics		Advanced Mechanics		
Energy and the Environment			Energy Conversion Systems	Energy Management and Efficiency	
			Computer Modelling and Design	Option	Design for Manufacture
	Business of Manufacture		Materials Failure		
Engineering Mathematics	Engineering Mathematics			Investigative Project	
	Professional Engineering Skills	Instrumentation Electronics and Industrial Control			

Options:

A	Digital Product Design	**B**	**Industrial Systems**	C	Renewable Energy Technology

Module name:	Applied Mechanics	Energy Conversion Systems	Computer Modelling and Design	Instrumentation Electronics and Industrial Control	Further Engineering Mathematics	Professional Engineering Skills	Business of Manufacture
Length of module	Year Long	Year Long	Year Long	Semester two	Year long	Semester one	Year long
Students on the module	All Mechanical Year 2 (Full & Part Time)	Mechanical Year 2 Full Time & Year 3 Part Time	Mechanical Year 2 Full Time & Year 3 Part Time	All Mechanical Year 2 (Full & Part Time)	All Mechanical Year 2 (Full & Part Time)	All Mechanical Year 2 (Full & Part Time)	All Mechanical Year 2 (Full & Part Time)
Teaching structure	2 members of staff, teaching alternate weeks	1 main member of staff with a small number of topics covered by another member of staff from the department	2 members of staff	2 members of staff, Alternate weeks	2 members of staff, 1 member of staff per semester	1 member of staff predominantly but with guest sessions from other university departments.	2 members of staff
Teaching style	Traditional lecture with some seminar sessions integrated into teaching time.	Traditional lectures, some seminar sessions integrated into teaching time.	Lectures with practical elements,	Lectures and seminars. Laboratory sessions	2 hour Lecture and 1 hour Seminar	Classroom based, mix of lectures & workshops.	1 half of the course is lectures with lab work, other half is discussion based
Assessment strategy	1 class test/ 1 assignment 15% Labs15% Final exam 70%	2 assignments 15%, 2 Lab reports 15% Final exam 70%	100% Portfolio with assessed tests through the year	Final exam 100%	Final Exam 100%	3 pieces of coursework, no final exam. 35%, 35% and 30%.	Lab report 20% Final Exam 80%
Feedback methods	Written feedback on assignments and lab reports	Written feedback on assignments and lab reports	One-on-one feedback on the tests	Formative feedback on practical tasks	Formative feedback in weekly seminars	Formative feedback in workshops and lectures. Written and verbal feedback.	

APPENDIX F

Information Sheet – (2009)

Project Title: Improving Student Understanding

Name of the Researcher or Project Consultant: Jenna Tudor

Name of participant:

This information sheet is to let you know some details about the research project I am carrying out into student perceptions and approaches towards studying on Engineering degrees. I am giving you this information so that you are aware of my research activities and how they may relate to you.

Project aims:
The main aim of this research is to allow me to understand the areas of strength within the Mechanical Engineering course here at XXXXXXXX and to identify which factors are the most important in terms of developing students' understanding of a subject.

Information required and outline of any potential risks involved:
I will be observing lectures, labs and seminars and interviewing some Engineering students so that I can understand what course content is being delivered, what teaching methods are being used and what common difficulties students might be experiencing. I will also be asking all students to complete a questionnaire and answer some questions by email. The data collected (from observations, interviews, email questions and questionnaires) may be used in printed documents but all data used will be completely anonymised so that none of the individuals that have taken part can be identified.

How the information will be stored and published (if applicable):
At XXXXXXXXXX University we have to be very careful that the information you give us will remain anonymous and confidential. Although I will ask you to complete your name on the consent form this is the only time I will ask for it; any specific help you give me towards my research will not ask for your name. Any written information e.g. transcript from interviews will be stored in a locked filing cabinet and I am the only one with access to it. Any electronic information will be password protected and again, I will be the only with access to it.

Any information you give will only be analyzed by myself, it will be completely anonymised and presented in a format that will not identify you to anyone else. The information will be used only for the purposes of the research project, that is, for the purpose of developing ideas to help students improve their understanding, (to make learning better) and for my PhD thesis. I may also decide to give conference presentations or write an article for an academic journal to explain my findings but again any data include would be completely anonymous.

The main findings from the research will be used to inform teaching in future years.

Any other information deemed relevant to the project:

I hope that my research will be of a benefit to all future Engineering students and lecturers at Northumbria. Thank you very much for taking the time to read this and please let me know if you have any objections to completing my research.

Many Thanks

Jenna Tudor
11 Sept 2009

APPENDIX G

CONSENT FORM –Sept 09

Project Title: Investigating Student Approaches and Perceptions in Engineering

Name of the Researcher or Project Consultant: Jenna Tudor

Name of participant:

In accordance with the Data Protection Act 1998 we are required to request your permission to use your information in our research.

I consent to take part in this project.	☐
I have had the project explained to me by the researcher **and been given an information sheet**. I have read and understand the purpose of the study.	☐
I understand I can withdraw my consent at any time, without giving a reason and without prejudice. I understand that my participation in this research will **not** effect my assessment in any way.	☐
I know that my name and details will be kept confidential and will not appear in any printed documents and that all information will be anonymised before being shared.	☐
I am willing to complete a questionnaire at the end of semester 2 about my approaches to studying and my perceptions of my learning situation.	☐
I am happy to receive simple one-click response questions by email.	☐
I understand that the researcher may ask to interview some students. I understand that I do not have to agree to be interviewed unless I wish too, however if I do agree to be interviewed I understand that any data collected will be confidential.	☐
I understand that data collected may be used in printed documents but that all data used will be completely anonymised so that none of the individuals that have taken part can be identified.	☐

- Information will only be used for the purposes to which you agree and it will be kept in a secure environment for up to three years and will then be disposed of in line with Northumbria University's retention policy.
- All information given will be anonymised and none of the participants will be identifiable in the project report or other publications. Copies of any reports or publications will be available on request to participants.

I have been given a copy of this Consent Form.

Signed: **Date:**

Researcher/Project consultant: I confirm that I have explained the project to the participant and have given adequate time to answer any questions concerning it.

Signed: **Date:**

APPENDIX H

Example of an Interview Schedule

Interview 1 – example of interview schedule

Prior to interview

- Ask for student number to use as identifier. Confirm Full or Part time attendance.

Last Year

- Previous education? have they come straight from school, college, etc?
- Any work experience?
- Why you chose mechanical engineering?
- Last year did you read much around the topics in energy and mechanics?
- Did you try to remember formula or the theory as well?
- Which subject did you think was most important last year?
- What percentage of tutorial sheets did you do? For Mechanics and Energy
- Did you tend to work independently last year, or ever with others?
- Do you think you're better at mechanics or thermo? Did you results last year reflect this?

Expectations

- Which subject is most important in your timetable this year for you personally?
- Which do you think least important to you this year?
- How much independent work do you expect to do per week this year?
- How have first few sessions of Mechanics and Energy been? Good points, worst points?
- Have done any work at home yet?
- How have you found pace, pitch?
- DO you understand reason for doing the topics you're doing?
- Have any things preventing or hindered your learning so far?
- How are notes given/made in mechanics or thermodynamics? Do you have a preference?
- Could you explain how you would go about solving a problem in mechanics, is it any different to thermodynamics?
- How do you find your timetabling this year? Do you think mechanics and energy at the best times?
- Do you intend to do anything differently this year to last year?
- Which subject do you prefer, out of all, and out of Energy & Mechanics?
- Where do you see yourself in 5 years, how do these subjects fit into your goal.

Learning

- Learning – was does it mean to you to learn, how can you tell if you've learned something?
- How can you be sure you've understood something?
- How do you try to ensure you have learned something?
- What usually helps you learn?
- Peers – discussing, do you find it helpful talking through problems or topics, who would you talk through it with?
- Can you relate the topics you have covered so far to real life? How?
- Assessments, do you feel that they help you learn? Final exams, class tests and labs from first year – which helped the most
- Lecturer –are they enthusiastic? Do they speak with clarity/explain clearly? Do you ask them questions? Are they patient if you or someone in your class doesn't get something straight away?

Approaches

- I know its early in the year but last week, did you do any energy or any mechanics outside the class - approaches (what do they actually do?),
- Has your interest in these subjects changed this year

- Do you usually go back over work
- Have you had to read about the topics you have covered so far?
- Do you tend to agree with what the lecturers say, have you ever asked further questions?
- Do you have any kind of organised study plan?
- How often would you say you attended energy and mechanics last year? And this year? Are there any subjects you could afford to miss?
- Have you found any of the classes or concepts this year difficult? How do you find the terms used? Do you find them confusing?

Demands/opinions of the module

- Do you find subjects are following each other logically, does that make a difference to you?
- Have you developed your ideas or improved your understanding of anything this year
- Are you enjoying the class, any more than others?
- Have you got any idea how your doing so far? Have you had any feedback yet? If so, was it helpful?
- What do you think need to do to pass this module?
- Which module has required to most work so far?
- Do you prefer numerical or written questions, why?
- What would encourage you to read more?
- When would you do more work?
- Could uni do anytihng to support your learning more?
- How would you rate the difficulty of energy and mechancis compared to your other subjects? Are there any that are more/less difficult? What do you think makes it more/less difficult?
- What do you think helps you improve your understanding the most (the labs, lecture, seminars, other)? What do you feel helps you less? why
- Good points and bad points about lectures/labs/seminars? Any way these could be improved?
- Is there anything that worries you in/about this module?

Questions related to course content

- Do you understand why Dimensional Analysis is used? Do you think you could use it now? Was it a harder or easier topic than others? Reasons?
- Second Law of Thermodynamics – do you understand what the second law means? What the implications of it are? Do you understand the need to cover it as a separate topic?
- What have you covered in Mechanics so far…

Assessment

- How do you feel about the way your course is assessed 70, 15 and 15%?

Approach to the module

- Is there anything about your circumstances that particularly affects your work on this module?
- Has there been anything you haven't understood/not been able to do, what have you done about it?
- Which subject are you finding most difficult?

Any other points you would like to raise?

APPENDIX I

Coding Example

Excerpts of Transcript Data – Second Interview, Student X	Coding Examples
Okay, so I'll just start off with how you think this year is going compared to last year. Well there is no, I mean it's fine, I probably would have said it the same time last year but I think there's no kind of, well, there was a lot of class tests last year so you had sort of markers as an indication of how well you were doing so you kind of know whether to buck up your idea or not, whereas this year is just a constant stream of assignments, and so I think I'm doing okay, but I won't actually know until you know the final year. So I guess it's okay, but I have no markers to sort of show otherwise. **Discussing Design....** Yes, I mean, in fact that's probably the only class where we've had regular weekly assignments. They're okay, it's definitely a better course or a better subject. I mean I spoke to the second years last year who did that topic or subject, and they didn't do anything like that, so I think this is better and it's more practical and it applies, you know, some of our base knowledge into solving these problems. But I just think there is just too much, there are too much assignments. I don't know if you want me to talk about his teaching techniques... Okay, he kind of, again, this is something I notice with a lot of lecturers, there's an element of assumed knowledge, although in the second year most of the topics we've already done so that's fine, but in the Design one, he completely assumes knowledge and just taught us, it was just very superficial, his teachings, you know, so there wasn't much depth, assumed that we knew what to do and then just threw us into it. **We tell them what we need and they come back to us with which rooms we can have, which rooms are big enough, when we can get them.** I know that you're dealing with part-time students here, but to be honest, a ten-hour day is not… I mean as teachers you all know that people lose interest after 4 or 5 hours, but 10 hours is a long day, you know, you have an hour for lunch and there's not even time for you to absorb anything...	• Difficult to Judge Progress • Demands of a course assessment regime & Workload • Feedback • Curse structure • Discipline Preconceptions • Relation of theory to practice • Workload • Previous experiences • Teaching quality • Teaching methods – strategy • Effect of lecture

APPENDIX J

Except from a lecture observation (pilot phase)

Observation of Energy Module - 2nd October

Observation of Introduction to a new module at the start of an academic year:

- Handout given for topic
- OHP shows break down of teaching for the semester by topic
- Welcome and Introduction, contact info for lecturer given out. Assessment structure given
- Learning outcomes: conceptual, Procedural and Application.
- Reading: authors names given but not the titles of the books.
- Relevance of the subject explained in relation to car engine (air/fuel mix) and combustion and heat transfer examples.

Use of questioning and student interaction during teaching

- Lecturer questioning during the session, on several occasions he asks a question then quickly answers himself, for example:

  "Can you give me a number with a dimension? Without a dimension?" He then goes straight to explain what a dimensionless number is, why they are used "to solve problems with models and prototypes" and explains that "just scaling down is not enough because of the Area and Thermodynamic similarity, these depend on groups of variables."

- Students are asked to solve a simple problem using a given formula and then the class are openly asked for the solution. One student responds with the correct answer, the class are then prompted to give the units, one student shouts the units out and is correct. Rapid, closed-response, interaction.
- When the lecturer discusses an example of 'a tap' there is some discussion amongst students as terms which seem to be new to them, and unfamiliar notation, is written and explained on the board.
- A question is asked about Bernoulli's equation; a few students say the correct answer, this links directly to what students covered in first year.

Perceptions and Practices in Undergraduate Mechanical Engineering

a

This questionnaire has been designed to allow you to give a brief overview of your experiences of the course and to allow you to indicate how you have gone about learning and studying.

Please indicate whether you are a: ☐ Full time student ☐ Part time student ☐ Full time Funded (fees paid by employer)

If you were interviewed please put your initials here so you responses can be considered appropriately in the analysis of the questionnaire _____

In this questionnaire any work you do outside of timetabled hours is referred to as '**independent study**' e.g. work you do on assignments, tutorial sheets, reading, problems from books, revision etc

Please tick the box that applies to indicate your answer for the following questions.

agree ✓ *agree somewhat* ✓? *unsure/neither agree or disagree* ?? *disagree somewhat* x? *disagree* x

What do you expect to get from the experience of higher education?	✓	✓?	??	x?	x
1. I hope the things I learn will help me to develop as a person and broaden my horizons.	☐	☐	☐	☐	☐
2. I'm focused on the opportunities here for an active social life and/or sport.	☐	☐	☐	☐	☐
3. I hope the whole experience here will make me more independent and self-confident.	☐	☐	☐	☐	☐
4. I want to learn things which might let me help people, and/or make a difference in the world.	☐	☐	☐	☐	☐
5. I want to study the subject in depth by being involved in a range of interesting modules.	☐	☐	☐	☐	☐
6. I mainly need the qualification to enable me to get the job I want.	☐	☐	☐	☐	☐
7. When I look back, I sometimes wonder why I ever decided to come here.	☐	☐	☐	☐	☐
Approaches to learning and studying	✓	✓?	??	x?	x
8. I have generally put a lot of effort into my studying.	☐	☐	☐	☐	☐
9. Much of what I've learned seems no more than lots of unrelated bits and pieces in my mind.	☐	☐	☐	☐	☐
10. In making sense of new ideas, I have often related them to practical or real life contexts.	☐	☐	☐	☐	☐
11. On the whole, I've been quite systematic and organised in my studying.	☐	☐	☐	☐	☐
12. It has been important for me to see the reasons behind things.	☐	☐	☐	☐	☐
13. I've tended to take what we've been taught at face value without questioning it much.	☐	☐	☐	☐	☐
14. Concentration has not usually been a problem for me, unless I've been really tired.	☐	☐	☐	☐	☐
15. I've just been going through the motions of studying without seeing where I'm going.	☐	☐	☐	☐	☐
16. If I've not understood things well enough when studying, I've tried a different approach.	☐	☐	☐	☐	☐

Subjects & Classes	✓	✓?	??	x?	x
17. In some subjects I am unsure what I've actually learned.	☐	☐	☐	☐	☐
18. I have done less independent study for one subject than others this year.	☐	☐	☐	☐	☐
19. I choose carefully which timetabled sessions to attend.	☐	☐	☐	☐	☐
20. Mechanics and Energy were more difficult than other classes this year.	☐	☐	☐	☐	☐
21. My strengths in subjects this year are the same as last year.	☐	☐	☐	☐	☐
22. The business and manufacturing module is not as important to engineers as other modules.	☐	☐	☐	☐	☐
23. It was clear to me what I was supposed to learn in most subjects.	☐	☐	☐	☐	☐
24. You have to really understand the subjects to get good marks.	☐	☐	☐	☐	☐
25. Space and comfort in lectures affects how much attention I pay to classes.	☐	☐	☐	☐	☐
26. Lectures and tutorials are taught and organised in line with my expectations.	☐	☐	☐	☐	☐
27. I would need to have a significant problem that was affecting my learning before I would ask a question in a lecture.	☐	☐	☐	☐	☐
28. I do not think it is appropriate to take up time in lectures asking questions	☐	☐	☐	☐	☐
29. I put more effort in to subjects that seem to be organised well.	☐	☐	☐	☐	☐
30. Without worked examples in a lesson it is difficult to see what I've learned.	☐	☐	☐	☐	☐
31. Without handouts it is difficult to understand what I'm learning.	☐	☐	☐	☐	☐
32. What we were taught seemed to match what we were supposed to learn.	☐	☐	☐	☐	☐
33. The lectures, handouts and other materials we were given helped me to understand the unit.	☐	☐	☐	☐	☐

Ways of Learning	✓	✓?	??	x?	x
34. I like to be taught subjects in small steps building up to a bigger picture.	☐	☐	☐	☐	☐
35. I do less independent study for modules that aren't important to me.	☐	☐	☐	☐	☐
36. Throughout this year I have chosen to work with others on several occasions.	☐	☐	☐	☐	☐
37. I am careful how much knowledge I share with other students.	☐	☐	☐	☐	☐
38. I've put more hours into my weekly studying compared to last year.	☐	☐	☐	☐	☐
39. Last year I needed to ask my friends more about how to tackle work.	☐	☐	☐	☐	☐
40. Sometimes when a task is easier I put less effort in and don't do as well as I could.	☐	☐	☐	☐	☐
41. If I am finding something difficult in classes my first response is to ask other students.	☐	☐	☐	☐	☐
42. I need time working on my own to really learn something.	☐	☐	☐	☐	☐
43. I have done more independent study than I planned to do this year.	☐	☐	☐	☐	☐
44. I have done more independent study for Mechanics and Energy than other subjects.	☐	☐	☐	☐	☐
45. Talking with other students helped develop my understanding.	☐	☐	☐	☐	☐

PLEASE TURN OVER ⇨

Assessments

	✓	✓?	??	x?	x
46. During the year my independent study mostly focussed on what was assessed.	☐	☐	☐	☐	☐
47. I often use formulas without trying to understand the theory.	☐	☐	☐	☐	☐
48. At least once this year I have left work until near the deadline and had to ask other students for help.	☐	☐	☐	☐	☐
49. I used the assignment schedule to help me plan my work.	☐	☐	☐	☐	☐
50. My marks so far are reflecting my effort and my learning.	☐	☐	☐	☐	☐
51. For tests I like to prepare on my own.	☐	☐	☐	☐	☐
52. I often discuss assignments with others who are at a similar academic level as me.	☐	☐	☐	☐	☐
53. I plan to concentrate most on Mechanics and Energy for the exams.	☐	☐	☐	☐	☐
54. The handouts have been enough to help me do most assessed work.	☐	☐	☐	☐	☐
55. Assignments have helped me learn as much or more than class tests.	☐	☐	☐	☐	☐
56. I am leaving tutorial problems until the end of the year so I can use them for revision.	☐	☐	☐	☐	☐
57. It was clear what was expected in the assessed work for the course.	☐	☐	☐	☐	☐
58. The feedback given on assessed work helped me to improve my learning and studying.	☐	☐	☐	☐	☐
59. There is at least one subject that I'm aiming to just pass rather than really understand.	☐	☐	☐	☐	☐
60. Lack of class tests has made me unsure of my progress this year.	☐	☐	☐	☐	☐
61. I am going to be tactical in choosing what to prepare for some exams.	☐	☐	☐	☐	☐

University Structure and Staff

	✓	✓?	??	x?	x
62. I put less effort into subjects when I don't think the lecturer teaches well.	☐	☐	☐	☐	☐
63. Unprofessional staff (e.g. poor timekeeping) affect how seriously I work towards a module.	☐	☐	☐	☐	☐
64. Interactions with most staff have been beneficial to my learning.	☐	☐	☐	☐	☐
65. I need less direction from staff this year than last year.	☐	☐	☐	☐	☐
66. I find it difficult to find time to ask staff all the questions I have.	☐	☐	☐	☐	☐
67. The workload has been too heavy at times for me to really learn.	☐	☐	☐	☐	☐
68. The timetable has made it easy for me to do my own studying around lectures.	☐	☐	☐	☐	☐
69. Access to rooms and resources has helped me learn.	☐	☐	☐	☐	☐
70. It hinders my learning when staff refer me to a book instead of giving me the answer.	☐	☐	☐	☐	☐
71. The quality of some teaching hasn't been what I expected.	☐	☐	☐	☐	☐
72. If teaching isn't ideal I ensure I understand the material by doing independent study.	☐	☐	☐	☐	☐
73. Most staff do enough examples in their classes so I don't need seminar sessions.	☐	☐	☐	☐	☐

Personal

	✓	✓?	??	x?	x
74. Second year requires you to be more responsible for your own success than first year.	☐	☐	☐	☐	☐
75. I have made a conscious decision about the type of student I am.	☐	☐	☐	☐	☐
76. I am more confident in my own ability this year.	☐	☐	☐	☐	☐
77. I have enjoyed this year more than first year.	☐	☐	☐	☐	☐
78. I enjoy high workloads and difficult tasks as a chance to prove myself.	☐	☐	☐	☐	☐
79. When I feel like I've learned a lot it doesn't always show in my marks.	☐	☐	☐	☐	☐
80. I am more motivated than in first year because this year counts towards my final mark.	☐	☐	☐	☐	☐
81. Personal factors have had more negative affects on my learning that anything at University.	☐	☐	☐	☐	☐
82. If there are small things I am unsure of I wait until I revise for exams to try and understand them.	☐	☐	☐	☐	☐
83. Mechanics and Energy were the more important than other subjects this year.	☐	☐	☐	☐	☐
84. I am motivated by a fear of failing.	☐	☐	☐	☐	☐
85. I have found it difficult to maintain a constant motivation & effort through the year.	☐	☐	☐	☐	☐
86. The subject material is much more difficult this year.	☐	☐	☐	☐	☐
87. I often write extra notes or add my own notes to handouts.	☐	☐	☐	☐	☐
88. I found most of what I learned in this course really interesting.	☐	☐	☐	☐	☐
89. The amount of work I was required to do was what I expected.	☐	☐	☐	☐	☐
90. I am rarely satisfied that my work is as good as it could be.	☐	☐	☐	☐	☐

91. How well do you think you're doing this year? Please try to rate yourself **objectively**, based on any marks or comments you have been given.

very well		*well*		*quite well*		*about average*		*not so well*		*rather badly*	
9	8		7		6		5		4	3	2	1
☐	☐		☐		☐		☐		☐	☐	☐	☐

Please check back to make sure that you have answered every question.

Thank you very much for spending time completing this questionnaire, it is much appreciated.