

# **An evaluation of motivation in engineering students, employing self-determination theory**

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## **1.0 Abstract**

*This paper examines the motivation of a group of students in the Department of Electronic and Computer Engineering at the University of Portsmouth. An expected outcome of the study is the enhancement of the student experience, through improving both the study environment and the goals that are set so that each contributes in a positive way to every student's motivation.*

*The study attempts to measure 'intrinsic' and 'extrinsic' motivation of students by employing qualitative data-gathering methods, including questionnaires and semi-structured interviews. Historic data has also been consulted to supply additional evidence, for instance the personal statement and the grades and subjects obtained prior to entry, which help identify primary influences in students' motivation.*

*Whilst most students may be expected to demonstrate both intrinsic and extrinsic motivation, this, limited, study indicates that many at the Department of Electronic and Computer Engineering at the University of Portsmouth operate more intrinsically. If confirmed by more extensive research, such a finding suggests that students might benefit from more loosely specified assignments; giving them freedom to choose from their laboratory work and assignments aspects in which they have a greater personal interest. This hypothesis is supported by comments received at interview with students.*

## **2.0 Introduction**

An unpublished departmental survey between 1997 and 2000 found there to be little correlation between a student's performance in school or college and the performance in the department. Part of the purpose of this investigation is to find other metrics which might be used to predict success at University. Subsequently, the importance of student motivation and learning at University has been confirmed by the National Student Survey. Thus, a study of student motivation may enable pedagogical interventions to be adjusted to enhance students' learning experiences. One result of this would be improved student engagement and satisfaction; an additional effect could also be reduced attrition.

Previous studies (for example Bagg, 1970; Bridges, 2001 and Furnham et. al, 2003) have attempted to identify metrics which accurately predict student success; ranging from the use of A-level grades to specific aspects of a student's personality. The use

of A-levels, in particular, was expected to anticipate performance at University - but has been judged unsatisfactory (Fullick and Fullick, 1991). However, personality traits were found to be correlated with academic performance by Furnham et. al (2003).

Based on the results from an extensive study, McManus and Richards (1984a) suggest that academic ability should be only one of the factors used in appraising students for entry to higher education courses. They suggest (1984b) that entry criteria could also include personal interests and community service - qualities used when assessing candidates in interview.

A study by Hoad-Reddick and Macfarlane (1999) classified data from the UCAS form of dentistry applicants. Their categories included information on the choice of career, team and leadership experience, evidence of manual dexterity and other extra curricular activities. Although, when correlating this information with student performance, they found only that those students who had taken biology were less likely to fail.

A Treasury report (2003) states that output is not only affected by the input standard and the quality of the institution, but also by the motivation of the student. It is also suggested elsewhere that an increase in the motivation of students can be linked to reduced dropout rates and increased success in students (Kushman, Sieber and Harold, 2000). Studies into the way that motivation is nurtured have found a positive correlation between actively developing a 'motivating environment' and student performance (Rebolledo-Medez, et. al, 2006; Turner and Patrick, 2004).

Investigations with high school and college students have found that the context with which work is presented as well as the learning environment had an effect on a student's learning and performance. Vansteenkiste et. al (2004) classified motivation as either a student's desire for money and self-image (extrinsic) or a student's desire for personal growth (intrinsic). They developed learning material and set it in either an intrinsic or extrinsic context. They found that setting work in an intrinsic context improved the student's performance. They also used either a controlling learning environment or an autonomy-supporting learning environment. They found that the autonomy-supporting learning environment aided the student's learning and performance more than the controlling learning environment.

### **3.0 Motivation**

Motivation has been conceptualised in different ways by different theorists. For example, by evaluating the time they spent on the task, assessing personality traits, or various cognitive-based processes (Atkinson and Raynor, 1978; Dweck 1988). Many studies on motivation have focused on the goals that students can set and how they achieve those goals (Bandura, 1977; Dweck, 1986). They have not identified the reasons why students have a desire to achieve those goals. Self-determination theory addresses the cause of this desire and suggests that people wish to develop themselves and to master challenges that confront them. Self-determination theory identifies two causes of desire to study; the need for recognition, praise and/or money (extrinsic motivation) and the need to fulfil an interest (intrinsic motivation) (Deci et. al, 1991). Both intrinsic and extrinsic motivation can be loosely linked with the theory of learning styles proposed by Marton and Säljö (1976). Intrinsically motivated students can be thought of as taking on a 'deep' learning style, they try to understand the reasoning behind the academic work that they are doing. Extrinsically motivated students can be referred to as 'surface' learners, learning the facts that they think they will be tested on. Self-determination theory also states that

environment affects self-determination (Vansteenkiste et. al, 2004). An engineering department may therefore consider how to increase students' self determination by adjusting pedagogical interventions and enhancing their learning experiences.

In a previous study, Baillie and Fitzgerald interviewed students who withdrew from Imperial College engineering degrees, in order to discover the reasons why they had left (Baillie and Fitzgerald, 2000). They suggest that students were more extrinsically motivated by living in London and by the University's reputation; than intrinsically engaged by a desire to learn about engineering. In another study, Rowe (2001) found that first year engineering students succeeded by having a 'reproducing/surface' rather than a 'deep' learning style, which may further indicate that current HE assessments do not necessarily require successful students to be intrinsically motivated.

#### **4.0 Context and Practice**

The learning culture of a department is required to ensure that students' self-determination is increased; and to include this in assessing departmental performance. This is recognized in the collection of student feedback from every module; and the National Student Survey. We require all students to develop a *constructivist* approach to knowledge of their subject area, rather than merely rewarding their ability to learn by rote and/or their exam technique.

That conflicts sometimes arise in applying this approach is exemplified by a recent discussion with a cohort of students recruited from the Royal Navy. They were looking forward to coming to University since all their learning to date had been a surface approach; learning for exams. They expected that HE would demand they adopt a deep learning style. However, they reported that the quantum of content to be completed forced them to revert to a surface approach or risk falling behind the rest of the class. In this instance, the learning environment thwarted, rather than supported, students' proclivity for active engagement and growth.

The department has historically used 'traditional' engineering teaching methods, which are geared towards the students knowing how to solve set problems rather than encouraging them to explore, challenge and thus construct 'their own' knowledge. However, some pedagogical approaches are used which assist students to explore their own understanding: project-based learning is used in all electronic engineering units in the first and second year, problem-based learning is used in first year software engineering units; and seminars are run for third and fourth year electronic manufacturing and technology exploration units. These are increasingly successful as lecturers learn how to use them to their full potential and adjust them to the characteristics of our student body. This study attempts to measure the motivation of students, with the purpose of discovering how to further assist teachers in the department to plan and design pedagogical interventions that will support students' active engagement.

#### **5.0 Methodology**

The methodology of this study consists of three parts:

1. recording a quantifier of student motivation before entering the department
2. designing, piloting and implementing a questionnaire
3. informal conversations/interviews with students

## 5.1 Student motivation before entering the department

The motivation of students is inferable from the 'personal statement' on their UCAS application form. Each personal statement was rated on a scale of one to three. An assessment of motivation has been made against judgements of the relative merits of the quality and quantity of evidence submitted in relation to the topics that they wanted to study. For example, if the student only stated their interest in generic terms then they are awarded a "1". Examples of such statements include "I have been interested in electronics since an early age" and "I would like to study electronics because I feel it is a fast moving industry".

A student's statement would be awarded a rating of "2" if they cited an example of their interest in the topics. This rating reflects an apparently more substantial knowledge base. Examples of statements that would be awarded "2" are "I have been learning C and C++" and "I have built some digital electronic projects".

A student's statement would be awarded a "3" if they gave evidence of their interest. Typically it might include a detailed example of an electronic or software project – for instance "I have built a sound sampling system with a PIC 16F870, the details are on [www.homewebsite.com/applicant](http://www.homewebsite.com/applicant)".

The personal statement rating is awarded based on the *highest rated statement* in the personal statement.

## 5.2 Designing, piloting and implementing a questionnaire

The questions employed in the questionnaire have been based on the results of investigations performed by Waugh (Waugh, 2002), Jacobs and Newstead (Jacobs and Newstead, 2000), Ray (Ray, 1981), Carré (Carré, 2000) and Gore (Gore, 2006). In addition to this the Self-Determination Scale, the Perceived Competency Scale and the Intrinsic Motivation Inventory have been interrogated to identify any sections or questions that had not been included. These scales and inventories are available on the website of Deci and Ryan (<http://www.psych.rochester.edu/SDT/>). The questionnaire originally consisted of a set of 53 questions and 20 words/statements using the Likert scale.

The 53 questions were grouped into twelve different sub categories; standards, goals, tasks, effort, values, ability, interest, learning from others, responsibility for learning, extrinsic rewards, intrinsic rewards and social rewards. Also included in the questionnaire were 20 words/statements that form part of a projective test. The use of these tests is sometimes considered controversial (Klinger, 1966; Entwisle, 1972), but it was felt that such a test may provide an insight into aspects not otherwise testable in the more conventional part of the questionnaire.

A pilot study of the questionnaire was given to 9 students, a selection of first and second year engineering students. The feedback from the pilot study resulted in the rewording of 3 questions and the removal of 4 questions that were considered confusing and which correlated very strongly with other, similar questions.

210 undergraduate students were selected to receive the questionnaire. The criteria for the selection of a student were that they had spent the majority of their education in the UK, that they had not attended independent schools and that they were not direct entry students or students who had transferred from other Universities or other departments. These criteria were applied in an attempt to minimise any possibility of

large variations in students' expectations and attitudes due to what may have been a significantly different exposure to education.

The questionnaire was sent as a word document to the email address of each selected student. The email contained details of how to answer the questionnaire and also a link to an online version of the questionnaire that the students could complete instead of using the word document. A reminder was sent out a week later to those who had not responded. This reminder was much shorter, being written after a conversation with a student who stated that they would have preferred just a simple email saying "do this" rather than explicit instructions regarding the questionnaire.

Whether the student identified himself in the response was left open. Ninety-six students responded to the questionnaire (46% response rate), of whom 6 did not submit their personal identifier. One student responded that he would not complete the questionnaire unless it was mandatory!

### **5.3 Informal conversations with students**

After the questionnaire results had been collated, opportunities for informal discussions with students were seized upon. This was opportunistic and involved inviting each student to elaborate on his reflections about the difference in experience between school/college and University, and how that experience affects their motivation. It also invited comment on how some of the pedagogical interventions used in University could ensure engagement and promote interest in the material.

### **5.4 Methodological limitations**

The assessment of motivation from the personal statement may not relate to the motivation of the student because of advice that the student received from either school teachers or from their parents. To test the repeatability of this methodology, 15 personal statements were assessed twice, with varying periods between their original assessment and their second assessment (from 6 months to two years). The second assessment rated the personal statements exactly the same.

The limitation of the questionnaire is associated with the limitation of the Likert scale. It is assumed that the difference between each successive point on the Likert scale is the same. This means that the difference between "strongly agree" and "agree" is the same as "neither agree nor disagree" and "agree". The questionnaire also has a large number of questions, so the student might not fully reflect on the question before answering. When piloting this questionnaire, it was answered in 5-15 minutes.

### **6.0 Findings**

All of the results from the questionnaire were tabulated and coded with '1' as "strongly agree", '2' as "agree", '3' as "neither agree nor disagree", '4' as "disagree" and '5' as "strongly disagree". For each completed return, the student's UCAS points and qualifications were also tabulated, along with the student's performance in each topic at University and the motivation rating of their personal statement.

## 6.1 Questions of significance

Identifying questions of significance is difficult because many questions were either rated as strongly agree or agree. However a numerical average of all responses was calculated and the four highest scoring and four lowest scoring questions were identified, table 1.

Table 1. Question identified as “significant”.

No	Question	Average response value
4	It is important to me to do well at this degree.	1.2
18	I value achievement in academic work.	1.5
35	I try to pay attention to my teachers in order to learn as much as I can.	1.6
36	I take personal responsibility for my academic learning.	1.6
28	I choose to do what I have to do.	2.4
31	I participate in class discussions to improve my understanding in academic matters.	2.6
40	I try to achieve academically because I like the competition with others that it brings.	2.6
47	After finishing each module, I felt pretty competent.	2.4

The questions with the highest tendencies towards strongly agree (4, 18, 35 and 36) show that students typically value and attach importance to their degree. They understand that they are responsible for their own learning; however they still value having a facilitator to guide them and give them advice.

The profile of question 28 across the year of study in the department is interesting. The question asks if the students ‘go over and above’ what is asked of them. The majority of first year students typically neither agreed nor disagreed with this statement. However second and third years tended to agree, perhaps suggesting that after a time in University students pick up a skill in doing only what is asked of them or only what will contribute towards their grade. Responses to question 31 indicate that many students are not confident with participating in class and lecture discussions. The response of students to this question does not vary between years, possibly indicating that the department doesn’t do enough to nurture students’ independence and sense of collegiality. The response to question 40 indicates that many students are not competitive with each other. An interesting aspect for the department is that few students feel that they are competent after completing a module.

Seven questions had interesting variation with the student’s year of study. Responses were looked for where there was a tendency towards or away from ‘strongly agree’ between the years, table 2.

Table 2. Questions with significant variation between the year of study.

No	Question	With an increase in year there is a tendency towards
6	I set myself realistic but challenging academic goals.	Agree
12	I make strong demands on myself to achieve in academic work.	Agree
25	I read widely on a number of academic topics outside of my degree area.	Agree
27	I always feel like I choose the things I do.	Disagree
29	I do what I do because it interests me.	Disagree
30	I enjoy doing this course very much.	Disagree

36	I take personal responsibility for my academic learning.	Agree
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The response to question 6 indicates students' understanding of what is realistic as they spend more time in higher education. The response to questions 12 and 36 give an indication that students begin to make stronger demands on themselves and their actions as they approach graduation. The response to question 25 might be indicative of students becoming more interested in more academic subjects as they approach graduation. The response to this question was strongly correlated with the response from question 24, which asked if students had an interest in a number of academic topics outside of their degree area.

For the department, the responses to questions 27, 29 and 30 are of concern, since they may indicate that, as students spend more time in the department, they realise that they have less choice in what they study. Limiting a student's choice could reduce opportunities to develop self-determination. A decrease in interest and enjoyment is correlated. A conversation with first year students indicates that they would be better motivated and interested if they were allowed greater freedom in choosing the application area of their coursework.

Some questions in the questionnaire demonstrate a medium-to-low Pearson correlation to the student's academic performance (a coefficient of approximately 0.3). These questions were from the 'standards and effort' group, associated with self-efficacy. This finding agrees with results from another study where self-efficacy was found to be a good predictor for success (Gore, 2006).

## 6.2 Intrinsic and extrinsic motivation

A comparison was made between those students who presented as more strongly intrinsic; those as more strongly extrinsic; and those who scored the same in the two areas, table 3. In order to achieve this, all responses from the intrinsic and extrinsic section of the questionnaire were compared.

Table 3. Distribution of motivation type.

	Intrinsic	Extrinsic	Same
Number	49	26	22

The findings suggest that more students are intrinsically motivated than are extrinsically motivated. However, for nearly all students the average response of intrinsic motivation and that of extrinsic motivation were only marginally different. The closeness of intrinsic and extrinsic motivation has been noted in another study (Leo and Galloway, 1996). Four students presented large differences between extrinsic and intrinsic motivation levels. Three of these were much more intrinsically motivated and they were all third years, with fail, 2:2 and 2:1 performances over their academic career. One was a first year who had entered University with relatively poor A-level results and perhaps was now determined to get results.

There were no significant differences in motivation levels between the different years of study.

The fact that the motivation found in the personal statement of the UCAS application is not correlated with student performance is of interest (Pearson correlation coefficient of 0.076). It suggests that the students are intrinsically well motivated before coming to University, but that assessments at University do not support their preference for and expectations of 'deep' learning opportunities, resulting in them not

performing as expected. However, the pre-University motivation rating was uncorrelated with the response to the extrinsic motivation questions (Pearson correlation coefficient of 0.072) and was only correlated with the response to the intrinsic motivation questions with a coefficient of 0.13. This gives indicates that the personal statement may not be a very accurate instrument in assessing students for admission to the department. It also shows that the personal statement might not provide strong grounds for inferring the actual motivation of the student.

## **7.0 Comment**

Two concerns emerge from this brief study. One is how we can improve the performance of students so that they achieve higher grades. The other is how we can improve the learning process of our students. Counter-intuitively, these may not be completely correlated, for the student who has perfected an examination and coursework technique may only have mastered 'surface' learning, that is learning for assessment. Students who exhibit both intrinsic and extrinsic motivational characteristics in approaching their discipline, may also want to develop themselves, and to be rewarded for that development, rather than simply pass exams.

While at University, students spend much of their time being assessed. This may encourage an attitude where they only work if there are marks attached to the outcome. The current method of assessing with constrained coursework and exams might not be the best way of nurturing development. Pressure to meet assessment requirements within an externally-determined time limit may not promote 'deep' learning among students who profit from opportunities to research, learn and develop. Conversations with students showed that they felt the use of open projects and seminars enabled them to fully explore and challenge their own knowledge.

A third year student suggested it was only important to succeed in 'the here and now' since what has been studied earlier merely serves as a ticket to get to 'where he is now'. This attitude is contingent with the feeling that the University experience will not matter as soon as they leave because they will then be faced with the 'real' challenge of work.

## **8.0 Conclusions**

This study suggests another, concerning what can be done to promote active learning while still ensuring that academic standards are maintained. The challenge is to seek to fulfil our students' intrinsic motivation by providing them with opportunities for independent, self-developmental learning.

This ambition must, of course, recognize the context where undergraduate studies are recognized as appropriate, within the public domain: a degree, organized as units or modules which the student has to pass. The place and priority awarded to study of a personal project may call for further attention.

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