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# Understanding Motivation in Large Groups of Engineering and Computing Students

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**Abstract:** *A wide variety of theories of learning and teaching recognises motivation as an essential prerequisite for successful learning. The ability to maintain and enhance student motivation is therefore one of the most important skills for HE lecturers, and many publications and training programmes devote considerable space and time to this matter. Applying this theoretical knowledge in practice, however, remains difficult due to the complexity of the concept and the number of different models of motivation available. Furthermore practical aspects, such as large size of many classes make it difficult for lecturers to identify the areas and level of interests of their students.*

*This project aimed at addressing these two difficulties: by developing a motivation profile of a large student cohort of a core engineering module (SCQF level 9) at Glasgow Caledonian it provided the basis for changes in learning and teaching activities aimed at enhancing student learning on this module. At the same time it examined whether two popular theories of motivation, included in a number of relevant publication and programmes in teaching and learning in Higher Education, can be successfully applied to a student population. Vroom's expectancy model (1964 in McKenna 2003) and Herzberg's distinction between hygiene and motivation factors, originated in studies on the workplace. Their applicability to HE students could thus be questioned. The results, obtained through two questionnaires based on these models, suggest that expectancy theory is relevant to students' learning experience and that greater transparency about the future valence of course contents can raise their motivation. Differences between hygiene and motivation factors, on the other hand, were less clearly visible.*

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## Introduction

"Motivation can influence what, when and how we learn" (Schunk. 1991 cited in Pintrich and Schunk. 1996. 6). Its central role for students' success is acknowledged in a variety of theories of learning and books for teachers. Race's, for example, places the need or desire to learn at the core of his model; the actual process of learning and reflection encouraged by feedback are only possible on this basis. While Race sees it as vital for all forms of learning, other authors stress its importance for the concepts of autonomous, student-centred or independent learning (Della et al. 2001, Gibbs in MacLellan 2008, 411, Bockaerts 1999 and 2003). Acquiring the skills to become a life-long independent learner is regarded as equally or even more important than acquiring specialist subject knowledge – in the authors' university this is one of the 3 key goals of the Learning and Teaching Strategy (LTAS, Glasgow Caledonian University, 2008). In such an environment, motivation is a basic requirement for students' success. Thus, good teaching has to aim at maintaining and enhancing student motivation, as it can both improve student learning in the context of a particular learning experience (cf. for example a study by Della et al. 2001) and, through successful learning, create the basis for a motivating cycle that allows future learning (Dearnley and Matthew 2007, 388).

## Project Rationale

The current paper is based on a project created to enhance student motivation on a large cohort of engineering and computing students (SCQF level 9) at Glasgow Caledonian University. In the academic year 2007-2008, students performed rather poorly on one of the core modules: Communications and the Internet. Only 48% achieved the intended learning outcomes to a degree that allowed them to pass the module. These results are problematic for a number of reasons: First, the experience of failure can be devastating for students and the failure can lower their motivation for future learning (Greasley. 1998, 105). In addition, the lack of success in both coursework and exam shows that many students do not acquire “usable knowledge” (Bransford et al. 1999, 5); i.e. they are unable to transfer their understanding of the course material onto exam problems and coursework. Finally, the low pass rates lower the school’s progression and retention rates.

In previous years, low attendance rates have been identified as one of the reasons for low pass rates in a number of modules. For this reason, monitoring attendance and contacting students who have been missing lectures has been implemented, which has contributed to improve the pass rates to some extent. This measure, however, cannot capture the complexity of the learning process, which is unlikely to take place if students mainly react to external pressures. Furthermore, external pressures do not support them in “engaging in active learning” (Biggs and Tan. 2007, 21), since this does not contribute to equip students with the skills and attributes to be “flexible, independent lifelong learners” (GCU. 2008, 1); a learning and teaching goal at Glasgow Caledonian University.

The project therefore aimed at identifying factors that can raise student’s motivation to do well on this particular module and to use this insight to make changes in teaching practice that could improve their learning both in the immediate context of this module and beyond. This paper explains how it addressed two of the obstacles to achieving this objective: the first is the great differences of motivating and de-motivating factors for every individual that result from the impact of internal and external influences on motivation. For a student cohort of over 200 students, it is impossible to gain an insight into the aspects that could raise the motivation of every individual student and to adapt their learning experience accordingly, despite the fact that their learning experience will be unique to every one of them. The second is the “sheer plethora of motivational constructs” (MacLellan 2005, 195) in educational and psychological literature that makes it difficult to choose an appropriate theoretical basis for the inquiry undertaken. While this variety reflects the complexity of the phenomenon and can offer experts a more detailed understanding, it “may be confusing and less than helpful in developing applications to improve academic achievement” (MacLellan. 2005, 195) for engineering lecturers who lack a thorough grounding in psychological research. For applied research in this context, it is therefore necessary to choose a theory that might not reflect the full complexity of motivation, but offers guidance in the exploration of motivating factors in a specific student group. The following paragraph explains how these difficulties were approached in the current project. The results and discussion session will then examine whether these answers could serve as a useful model for applied research in engineering education.

## Methodology

### Phase I

The suggested solution to the conflict between the individual nature of motivation and large groups is the use of questionnaires which enabled the lecturer to profile motivational patterns in the 2008-09 student cohort, while allowing space for individual voices. The questionnaires (c.f. Appendix A and B.) were administered by the subject lecturer to all students at the beginning of a lecture in the second half of the semester and were returned anonymously. This procedure ensured that all students who attended the module had a chance of participating, although this might have excluded students who were enrolled but did not attend the lectures for this module. Collecting them anonymously ensured that students did not feel that non-participation would leave a negative impression with the lecturer, but might have lowered the number of participants as well. The questionnaires contained open questions, which allowed an exploratory approach into the factors that enhance or lower students’ motivation, rather than asking for agreement or rejection of the lecturer’s assumptions. The answers of the open questions were progressively coded with the help of software for qualitative data analysis (*NVivo*), allowing a mixed, qualitative and quantitative analysis based on the categories established for closed questions and those identified during the coding process.

The questionnaires were based on two specific theories of motivation that were related to the lecturer's observations about potential reasons for a lack of motivation and recommended during the postgraduate certificate programme for teaching and learning in Higher Education: Expectancy theory (cf. questionnaire in Appendix B), as formulated by Vroom (1964 in McKenna, 2003), defines motivation as the product of *valence*; i.e. the value or relevance of the aim, and *expectancy*, i.e. the degree of difficulty associated with obtaining this goal. Relevance is thus at the centre of this theory, which allows a differentiation between different contexts in which the intended learning outcome can become relevant. This includes the students' programme of study, their professional ambitions in the future and their personal interest. In addition, a comparison between their evaluation of valence at the beginning of the course (albeit in retrospect; this weakness of the design has been eliminated for the second study conducted with the student cohort in 2009-10; cf. conclusions) and towards its end can show whether the problem is mainly an initial lack of motivation, or whether this is exacerbated by the structure and contents of the course. Examining the reasons why students attach high or low valence to the current module could help to identify which aspects could be emphasised further or reduced to increase this perception for future cohorts.

The second questionnaire (Appendix A) was inspired by Herzberg's observation that job dissatisfaction mainly arises due to the work context, including supervision, physical working conditions and salary among others (Herzberg et al. 1993, 113), whereas motivation is mainly "related to tasks" and their potential to allow employees to achieve visible success or personal growth. The questions are deliberately kept open, however, to avoid priming the participant into differentiating between the two types of factors and maintain the exploratory nature of the project. If found in student populations as well, Herzberg's distinction would be very attractive for lecturers, as the emphasis on tasks among the motivation factors would allow them to adapt their teaching and learning activities in a way that does not only avoid frustration but actively fosters motivation. While most student satisfaction surveys focus on organisational aspects of the student experience, tasks and activities would allow individual lecturers to exert a strong influence on their students' motivation and to help create the basis for successful independent learning that depends on motivation, not merely absence of frustration.

The differences between HE and the situation of employees for which they were first developed, however, raises questions about Herzberg's theory suitability to the educational context. Part of the analysis of this paper is devoted to this problem.

The use of the expectancy theory has been advocated by other practitioners as well (Howard, 1989), and it has been used in other contexts, such as students' perception of peer assessment (Friedman, 2007), but the current study could show whether it proves useful in planning the teaching and learning activities and environments for a specific student group. Herzberg, on the other hand, is rarely applied to teaching and learning. The study thus uses "the research process to support change and development" (Fox et al. 2007, 47) in the context of the lecturer's workplace, but is, at the same time, of interest to the wider community of teachers in HE whose reflection on "how they might teach even better" (Biggs and Tan, 2007, 41) identifies motivation as a key aspect. Although the nature of the questionnaires used does not allow definite answers to the second question, its result will provide some indication whether these models will be of use to their inquiries or not, and the analysis of the study's results will focus mainly on these questions.

## Results and Discussion

### Vroom

The first questionnaire was answered by 59 students. This only represents a third of the students enrolled in the module, but a substantial proportion of the students attending the last lectures of the semester. This involuntary pre-selection might impact on the results, as it can be assumed that the students who attended the last lectures were those with the highest motivation levels.

The analysis of the questions about valence shows how the results can be used to show tendencies across large groups of students. It showed, for example, that the perceived relevance of the module to both programme of study and personal interest, tended to be higher at the end of the semester than at its beginning (cf. table1). The majority of the respondents reported that they had neutral expectations before the module, and the number who saw it of very little or little relevance was higher than the number of those who saw it as relevant. This judgement applies to its perceived relevance to their programme of studies, but even more so to their personal interest.

Area of Relevance / Rating Chosen	1	2	3	4	5	n/a
Programme	5	11	29	13	1	0
Personal Interest	9	15	21	4	8	2

**Table 1. Student's perception of the module's relevance to Programme of Study and Personal Interest at the start of the course. 1 represents minimum relevance and 5 maximum.**

In both areas students claimed to perceive higher valence towards the end of the module when the study was conducted: although many students still give neutral answers, the positive ratings have increased in relation to both aspects (cf. table 2).

Current Relevance to	1	2	3	4	5	n/a
Programme	3	9	18	23	6	0
Personal Interest	8	7	17	21	5	1

**Table 2. Student's perception of the module's relevance to Programme of Study and Personal Interest at the end of the course. 1 represents minimum and 5 maximum.**

This development is less pronounced in a subgroup of students. The motivation of students on Audio Technology programmes was significantly lower in all areas, in their expectations before and evaluation after the course (table 3). Although a small improvement is visible, the number of students who see no or little relevance of the module to their programme, for example, remains the same.

Attribute / Value	1	2	3	4	5	n/a
Expect. Importance to programme	3	7	15	2	0	0
Importance for programme now	2	5	9	9	2	0

**Table 3. Development of perceived importance of the module for students on programmes in Audio Technology only (27 students in total).**

Identifying this specific group is helpful for two reasons: first of all it helps the lecturer to identify problematic groups whose needs can be considered when preparing the course for the next cohort. Secondly it allows a comparison of perceived valence and students' results. For Audio Technology students, the lower rate of perceived relevance is echoed in a lower pass rate. While 30% of them failed the module (21 of 73), this percentage was lower in the complete student cohort (19%). This connection suggests that a low degree of perceived relevance can hinder successful learning. The same conclusion could be drawn from the fact that the overall pass rate increased compared to previous years: this might have contributed to negative word of mouth on the module, which might have changed for students who had positive learning experiences during the semester. Although the study cannot demonstrate clearly that Vroom's model can be applied to HE, a comparison of its quantitative data with student pass rates can thus give indications that support the link between valence and successful learning.

If the expectancy model can be applied to student learning, the perceived degree of relevance alone is not sufficient to implement changes to the module that can raise motivation. The open questions, on the other hand, provide an insight into elements of the module that influence the level of valence. Such knowledge could then be used to foster motivation among future student cohorts. A good example of such elements can be identified in the results of the survey. Asked about particularly relevant aspects of the module, students named *learning about everyday technologies* in all three areas (career prospects, personal interests and programme of study). They enjoyed learning about networks, especially the internet and LANs, which are used by most of the students on a very regular basis. The answers related to the relevance to their personal interest are a good example of this tendency: 44 students gave answers related to networks in general, either in first, second or third place, choosing specifically the internet (13 answers among the 44) and LANs (6 answers among the 44 network

related ones) as their favourite topic. The second most popular aspect is mobile technologies (mentioned in a total of 10 answers as either their first, second or third interest). On the basis of this insight, lectures and tutorials can be adapted to emphasise where the technologies presented occur in their everyday life.

Another example is the role of successful learning. Where students felt that they had learned something, either something new or gained a better understanding of a topic, they rated valence to their programme of study (10 answers) and their career prospects (9 answers) more highly. The high number of generic answers to the question about the reasons why their personal interest has grown makes an interpretation more difficult, but here again a small group of students (5 answers) explains their more positive view with a new depth of understanding and the value of having gained more knowledge. These answers could be seen as confirmation of the idea that learning motivation follows good learning (Biggs and Tan. 2007, 37).

This results show that even if initial motivation is low, it can be increased throughout the module by providing students with the opportunity of successful learning experiences at the beginning of term. Although the present project did not use Vroom's equation to calculate motivation as the product of expectancy and valence in numeric terms, the concept of valence has proven to be useful, especially when identifying which aspects of the learning experience contribute more strongly to high valence.

## Herzberg

The results of the second questionnaire establish an interesting paradox in terms of Herzberg's theory. The emphasis on content as a factor that strongly influences the students' evaluation of the module's relevance could be regarded as an indication that Herzberg's model cannot be easily transferred to HE. The experience that successful learning enhances motivation, on the other hand could be regarded as a typical motivation factor related to a task and its potential for self-development. The results of the second questionnaire can shed further light on this.

The answers to the questions about factors that made modules inspiring or could cause dissatisfaction respectively were coded into a variety of different aspects, including the content taught, the relationship between students and lecturer, the structure of their learning experience (the order and format in which it took place), organisational aspects of the delivery, feedback and assessment, and teaching materials.

At first glance some of the answers are comparable to Herzberg's hygiene factors: students criticise specific patterns of behaviour on the part of lecturers, such as lack of punctuality (qu. 9) or monotone voices (qu. 5) and attitudes, including "unfriendliness" (qu. 41) or "being patronised." The central role of lecturers could be compared to the role of supervisors, whose behaviour Herzberg identified as a reason for job dissatisfaction. Similarly unhappiness with organisational aspects, such as the time of lectures, difficulties to follow long lectures or the sense that teaching lacked a clear structure are comparable to the physical working conditions in Herzberg's study, while unhappiness with assessment and feedback could be seen as the equivalent of salary related complaints. This area has to be considered very carefully, however, as many students criticised the perceived lack of guidance provided before assessment. While this might be a justifiable claim in some instances, this could also reflect disagreement about the role of independent learning. In this case the parallel to Herzberg would not apply, as this means that students disagree about the task that is expected of them, not the reward received.

The question about hygiene factors thus suggests that some parallels exist between the hygiene factors Herzberg identified for employees and students. This similarity is, however, called into question by the similarly high number of students who see content, which could rather be seen as related to tasks, or in other words, Herzberg's motivation factors, as the potentially most dissatisfying factor: while some students felt that overly technical contents was undesirable, others rejected anything that "tries to teach computer engineers about 'colours that match'" (qu. 06). The majority of students considered irrelevance to their programme of study or future as the main factor that caused dissatisfaction.

The parallels to Herzberg's study are further dispelled by the presence of the same two groups among the answers to questions a.2 and a.3 about factors that motivate students: here students identify the content of modules as the most important reason for their enjoyment of modules, specifically its relevance to their interests (qu. 44) or subject of study (qu. 24) or a direct relation to their chosen

career (cited by 3 students). In addition, they see tasks as motivating, such as “discussions” or “hands on work” (qu. 30 and 36). At the same time, however, they see positive experiences with staff, such as “enthusiastic lab tutors and lecturers” (qu. 27), or “good guidance” from lecturers (qu. 26) particularly motivating. The neat distinction between the types of factors is thus refuted. Paying attention to the aspects that were only named as hygiene factors, such as the organisational aspects listed above, can help to avoid student dissatisfaction, but in order to enhance learning by heightening students’ motivation, other means have to be employed.

## Conclusions

The increased perception of relevance visible in the survey cannot clearly be related to grown motivation and improved learning, but they are accompanied by a clear improvement in the passing rate compared to the previous student cohort from 43,6% and 84,3%. This suggests that their growing motivation could have been at the basis of this increase. Other factors, such as time constraints given due to part-time jobs or child care arrangement, or difficulties due to relatively low entrance requirements in Maths for some programmes could also be responsible for students’ difficulties with the module. Nonetheless, the parallel between growing motivation and the lecturer’s attempts to address relevance as a likely problem suggest that the improvement that has already been achieved could be increased further through specific efforts to emphasise the aspects students identified as particularly relevant. The results have been used for the preparation of learning materials in 2009-10 and a second survey accompanies these attempts.

The action research project has thus proven useful in identifying opportunities to enhance the motivation of students on this particular module. Nonetheless, the evaluation of these models of motivation has to be treated carefully: as results of a small scale study, they cannot be understood as a definite judgement on whether Vroom and Herzberg’s models can be applied to educational contexts in general. The lack of a clear distinction between hygiene and motivation factors suggests that it might not exist in HE in the same form as it does in the workplace, but this situation might be different for other cohorts. In addition, two problems could affect the results even for this specific module, some participants misunderstood the question about inspiring modules and related it exclusively to the module studied. Furthermore, the use of a retrospective valence rating might mean that answers are influenced by later experience with the module. For this reason, the study is being repeated in the academic year 2009-2010 in a slightly modified version. Despite these limitations the study has provided an opportunity to link theoretical knowledge about theories of learning and teaching with teaching practice. Vroom’s model has been successfully employed to highlight elements of the module that could be improved in order to enhance motivation. Herzberg’s hygiene and motivation factors could not be clearly identified for this student group. As a consequence these results have not instigated major changes to the learning experience. This result can thus guide future research into the motivation of large groups, both at GCE and other contexts.

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## APPENDIX A

### Questions from questionnaire based on Herzberg:

a.1) Can you think of a module that really inspired you?

Yes , the following module:

No.

a.2) If you answered "Yes", can you explain why this module was inspiring?

a.3) If you answered "no", what would a module need to do to inspire you?

a.4) Please name 5 factors that can make you very unhappy with any module in order of importance

## Appendix B

### Questions from questionnaire based on Vroom

b.1) What is your programme of studies?

b.2) How important did you think this module was for your programme of studies BEFORE it started on a scale from 1 (not important at all) to 5 (very important)?

1      2      3      4      5

b.3) How important do you think this module is for your programme NOW on a scale from 1 (not important at all) to 5 (very important)?

1      2      3      4      5

b.4) If your rating has changed, can you explain why?

b.5) Please name 3 aspects of this module that are most important for the rest of your studies.

b.6) What are your career plans following the completion of your degree?

b.7) Are you likely to use the knowledge and skills acquired in this module in a future job? Please rate this on a scale from 1 (not likely at all) to 5 (very likely)

1      2      3      4      5

b.8) Please name the 3 skills acquired in this module you are MOST likely to use in a job.

b.9) Please rate your personal interest in the topics covered in this module BEFORE it started (on a scale from 1 (not interested at all) – 5 (very interested)).

1      2      3      4      5

b.10) Please rate your personal interest in the topics covered in this module NOW on a scale from 1 (not interested at all) – 5 (very interested).

1      2      3      4      5

b.11) If your rating has changed, can you explain why?

b.12) Please name 3 aspects that were of greatest personal interest to you.

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