

Motives and achievements of first year students on the master programme in Engineering Physics at Uppsala University

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Abstract

The different motives that students have for their decision to enrol in the master programme in Engineering Physics (Civilingenjörsprogrammet i teknisk fysik) at Uppsala University in Sweden have been explored using an open-ended questionnaire. The answers have been qualitatively analyzed and twelve different categories of motives have been found. The two most dominant motives were *programme image* and *students' previous experiences of the school subject*. The different motives are presented and discussed in relation to a similar study made for Mechanical Engineering students at the University of Cape Town, South Africa. Two general student archetypes within the Uppsala student population are presented and discussed - the engineering-student and the engineer-to-be.

The relationship between motives for enrolling in the programme and academic achievement was explored by cross-referencing the motivational patterns of students with academic records. This analysis showed a connection between different levels of achievements and many of the found motives. In particular, it was found that the engineering-students achieved very good results during the first year whereas the engineers-to-be exhibited an increased tendency to achieve low results.

This empirical study has probed some of the complexities of the dynamics regarding student recruitment, achievement, retention and attrition at a Higher Education programme. The study exemplifies the usefulness of using a Discourse perspective when exploring such issues. The results can be used as inspiration for both future research and educational development.

Introduction

The issue of student attrition is of great concern, both locally (Andersson & Gelin 2008) and internationally (Yorke & Longden 2004, OECD 2008). The declining interest for programmes in science and engineering observed for many countries make the issues of recruitment, attrition and retention especially important for these areas. Our study was motivated by the need to improve and extend understanding of the dynamics affecting student recruitment, attrition and retention for educational programmes, in particular for the master programme in Engineering Physics at Uppsala University in Sweden.

A social perspective on physics programme studies

Research on attrition and retention has shown that the social aspects of participation in Higher Education play an important role for the students' academic choices. The Interactionist Theory of Tinto (1975) explains student departure from Higher Education as resulting from the interaction between individual students and the university as an organisation. This theory has been further refined (Tinto 1993, Braxton & Hirschy 2004) to include factors such as student entry characteristics and social integration. Starting from this modelling and drawing on the Discourse analysis of Gee (2005) we find it reasonable to expect that many different aspects of the students' identity can play an important role in the dynamics behind academic choices. This has motivated an empirical study on the motives that students have when deciding to enrol in the master programme in Engineering Physics at Uppsala University and the relationship between those motives and academic achievements.

Structure of the paper

As the paper has two major aims, exploration of motives and a study of the interplay between motives and achievements, we have chosen to present and discuss these results in two separate sections.

The first aim of this study was to investigate the different motives that students have for their decision to enrol in the master programme in Engineering Physics at Uppsala University. The results of this study is presented and discussed in the 'Exploring the motives for starting the programme' section of the paper.

The second aim was to explore the relationship between the held motives and the students' academic achievements during their first year of programme studies. The results of this part of the study are presented and discussed in the section 'Interplay between motives and achievements'.

Exploring the motives for starting the programme

Students' motives for enrolling in educational programmes have been subject of international research (see for example Dick & Rallis 1991, Jawitz & Case 1998, Reed & Case 2003). Science and technology has been one area of particular interest, due to the observed declining interest for starting study programmes in these fields seen in many countries (OECD 2006). Some universities study the motives of beginner students with initial questionnaires (see for example Orved & Westman 2007). Such initial questionnaires are however often based on multiple-choice questions with a few given alternatives, due to ease of analysis, and only give a limited view of the complexity of student motives. A qualitative study based on open-ended answers give a more multi-faceted view of the issue.

Method

The data for the engineering students' motives for enrolling in the master programme in Engineering Physics came from an open-ended questionnaire that was given to the first-year programme students in 2007 during their first week at the university. 67 of the

students (out of 101) completed the questionnaire, which consisted of questions dealing with motives, expectations and plans for a future career. In this study, only the issue of motive was analysed in detail. Some analysis was also done on answers regarding career plans to add greater depth to the discussion regarding motives.

The data was analyzed using a qualitative categorization process, based on grounded theory (Robson2002). An iterative open coding schedule was developed for the answer on the questions regarding motives. This qualitative analysis yielded twelve different categories of motives for enrolling in the programme. Some of these categories were not very common within the data, but were still kept due to their correspondence with categories from a similar study (Reed & Case 2003). All answers were then categorized and a frequency count was made.

Results

Our study identified twelve different types of motivations for starting the program held by the students. Seven of these motives were quantitatively more common, whereas the other five were much less common.

The two most common motives were both shared by around half of the students. These motives were the *programme image* and the students' *previous experience of physics as a school subject*. Another five motives were held by between 10 and 24 % of the students – *intellectual activities, flexibility and challenge, convenience, rewards and special career plans*.

Five other motives were also found, but these were only held by one or two of the students in this population. These five motives were *previous experience of engineering careers, university image, advice and opinions from socialisers, previous interaction with technology* and *the programme being a second alternative*. As these motives were quite uncommon among the students of the master programme in Engineering Physics, they will not be discussed in detail here¹.

The seven most common motives are elaborated upon in more detail below. The fraction of students holding this motive is given for each.

- **Programme image (51%)**

The master programme in Engineering Physics has a very strong image. Some even see it as an archetype for engineering master programmes. One of the two most common motives found for starting the programme was the aim to become part of this programme experience.

“It gives the impression of being a very good programme.”²

¹ All of these less common motives, but the university image, are discussed in more detail in the article of Reed and Case (2003). The university image motive relates to the students perception of the university and is seen more frequently among beginners enrolling to other Uppsala University programmes studied.

² All quotes used for illustration in this paper is taken from student answers and translated to English.

- **School subject (51%)**
 The programme is perceived as being closely related to physics as a subject. The other of the two most common motives for joining the programme was the students' previous experience of physics. The students choose to continue studying physics as he had enjoyed the subject at the gymnasium.
"I have always liked physics."
- **Intellectual activities (24%)**
 Many of the students were motivated by intellectual curiosity and a wish to understand more about the world around us, and the universe in general. This motive often also includes a wish for intellectual challenges.
"... was looking for a challenge and a greater understanding of how the world works."
- **Flexibility and challenge (21%)**
 This motive is based upon a wish for an interesting job in the future. These students see their programme studies as a path towards a broad career with many possibilities for variation.
"I would not like a boring job in the future."
- **Convenience (13%)**
 For some of the students, an important motive for choosing the programme was convenience. These students generally state that they had to study something and this programme happened for one reason or another to be a convenient choice. Two major factors for the convenience are found in the students' answers. One is that the programme is supposed to be such a well-established programme that you cannot go wrong choosing it. The other is that the student's earlier experience of physics and math leads him to believe that the programme should be suitably easy.
"I found no programme that was interesting enough so I choose something I was good at."
- **Rewards (12%)**
 The financial and vocational security of being an engineer in "Teknisk fysik" is seen as an important motive by some of the students. The expected high wages and perceived employment stability are both mentioned by the students as reasons for choosing the programme.
"I believe it will give me a secure future economically."
- **Special career plans (10%)**
 Some students have a very clear plan of what their future career would be. Their motive for starting the programme is that they perceive it to be the best path towards their future goal.
"I would like to work in a nuclear energy company."

Discussion

Some interesting observations regarding the motives of the students can be seen, especially in comparison to the results of a study of first year mechanical engineering students at the University of Cape Town, South Africa (Reed & Case 2003). There are similarities between these groups, such as the fact that they are starting a highly regarded

programme at a well-known university. There are also significant differences between their backgrounds, such as their society Discourse. Therefore it is reasonable to assume that their initial social identities, as seen from their motives for enrolling in Higher Education, would be qualitatively different. This can also clearly be seen in figure 1 below where results from both these studies are presented³.

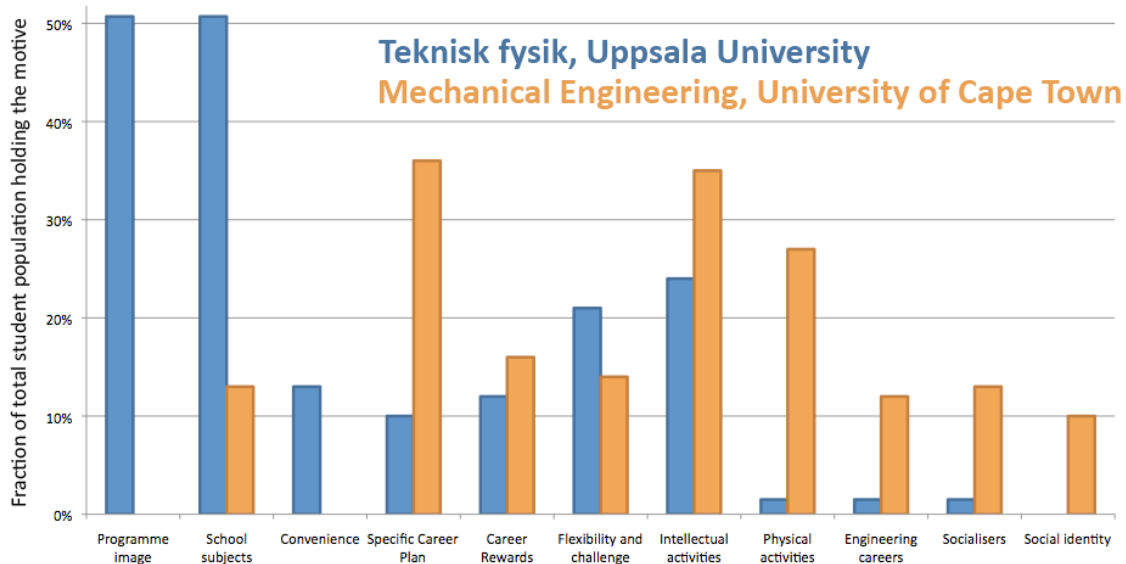


Figure 1. The fraction of students holding different motives for the different student populations.

The motive of the programme image is very important for the Uppsala students. They have chosen a programme to study based upon the perceived values of that programme. This is a very clear study oriented focus, where the student’s goal is the study programme per se and not the future career. This motive was not found at all among the Cape Town students.

It is also interesting to note that the motive of school subject is much more common among the Uppsala students. Half of the students have chosen to continue studying at the university on a specific programme based upon the previous study experiences. The dominance of these two motives (*programme image* and *school subject*) among the Uppsala students is, at least partially, due to the current view on higher education held by most of the Swedish students, and Swedish society in general. The outspoken goal that half of the Swedish students should continue into higher education has led to the students feeling “expected” to continue towards the university programmes. This is seen in many of the answers where the students say that they “are expected to study something” and that they “had to choose a programme”. It is quite natural that they choose this programme more due to study centred motives than career centred motives. This reasoning is also closely connected to the *convenience* motive, which is another motive only seen in the Uppsala student population.

³ The two motives of *university image* and the *programme being an alternative choice* do not contribute to the discussion and are therefore not presented in the figure.

The Cape Town students were more motivated by the *specific career plans* motive. The view of the programme as a path towards a specific future career is much more common among the Cape Town students.

The two motives of *intellectual* and, in particular, *physical activities* are playing an important role for the Cape Town students. The major difference relative to the Uppsala students is that very few Uppsala students hold the motive of *physical activities*. The actual physical interaction with technology and the objects engineers will work with and develop seems not to be of interest for them.

Two motives of little significance for the Uppsala students are *engineering career exposure* and the views of *socialisers*. The Uppsala students have had little previous contact with engineering. The importance of the opinions of people they socialise with in their choice of Higher Education programme is also not seen as important for the Uppsala students. It could however be interesting to further investigate the role of these two factors in the formation of the programme image many of the Uppsala students hold as their main motive.

It is interesting to note that the motive of *social identity* is not found among the Uppsala students. This motive is related to such factors as the social impact the student's future career will have upon society and the student's ability to make a contribution to the world in general. This motive is held by 10% of the Cape Town students. When looking in more detail on the future career plans of the students we find however some indications that a few of the Uppsala students also have such hopes for their future.

When cross-referencing all the different motives to each other and also with the students' answers regarding future career plans we find that two major student archetypes emerge from the student population.

The first of these is the **engineering-student**, who is motivated by the goal to study a good educational programme. This student archetype has usually had good previous experiences of the subject of physics. The student also expect that the programme studies probably will lead to a future employment, but has no clear idea about what this employment will be. Almost half of the beginner students can be seen as falling within this archetype.

"I don't know what will happen after the programme, but I believe that it will sort itself out along the way."

The other student archetype found is the **engineer-to-be**. This student see the programme as the path towards a future employment in the technology sector, sometimes related to research or some specific area of physics. Almost a quarter of the beginner students can be seen to belong to this archetype.

"I think the programme will help me get the job I want, as an engineer somewhere. Maybe Norway."

The interplay between motives and achievements

Students starting their studies with different motives can be seen as having differences in their starting identity when coming to the university. That could lead to differences in academic achievement, consistent with the theoretical framework discussed above. We have performed an analysis on study achievements related to motives to explore this issue.

Method

The study achievements of the engineering students during their first year of studies were assessed using the results recorded in UPPDOK, Uppsala University's database for study result documentation. Each student was classified as a high achiever, a low achiever or a leaver depending upon his or her results.

- **High achievers** took 35 ECTS or more of the 60 ECTS of the first year.
- **Low achievers** took less than 35 ECTS of the 60 ECTS of the first year.
- **Leavers** took less than 35 ECTS and stopped taking courses on the programme at some point during the first year.

The achievements of the students during the first year were then cross-referenced with their motives for enrolling in the programme.

Results and discussion

Correlations between motives and achievement trends during the first year were found for five of the most common motives. Some tendencies could also be seen for the other two common motives. There are of course individual students with most motives who become either of high achievers, low achievers or leavers. In this analysis we have looked at general trends seen for 'average students'. The relationship between motives and achievements are presented below together with tentative explanations based upon a further analysis of the relevant questionnaires and discussions with students, teachers and study counsellors.

Students holding the motive of *programme image* were found to achieve better results during the first year than the average student population. This group was also less likely to leave the programme. With the programme as the focus of their motive, these students have some sort of idea of what their programme studies will be like when they start. As long as those expectations are met the students are more likely to enjoy their studies and achieve good results. The motive of these students also has a rather narrow focus along the lines of 'I'm here to take the programme, which I perceive as good'. Therefore they are positively predisposed towards their study programme to begin with.

Students motivated by future career *rewards* are also found to achieve better. Within their motive these students perceive that their study efforts will be rewarded in a not so distant future.

Many of the students motivated by a *specific career plan* were low achievers during the first year of the programme. These students have a specific goal with their studies, but as the beginning programme courses are seen as unrelated to this goal the students are

poorly motivated to succeed. However, they still struggle on in an effort to one day reach their goals.

The students motivated by the *flexibility and challenge* of their future career were also low achievers to a larger extent than the average student population. A possible explanation for this would be a mismatch between the students' perception of their future careers and work forms during their university studies.

The motive of *convenience* has a clear correlation with the tendency to become a leaver. These students often chose their programme without any specific view of what it entailed. As the studies progress they leave the programme or become low achievers.

The *school subject* motive has a more complicated relation to student achievement. Students holding this motive in combination with a *programme image* motive were very successful, mainly becoming high achieving students. However, those students who only held the *school subject* motive mainly became low achievers or leavers. This might be caused by a conflict between their expectations of what physics studies should be, based upon their earlier gymnasium studies, and what they encountered at the university.

When looking at the two student archetypes discussed earlier we note that students belonging to the **engineering-student** archetype generally achieve very good results during the first year. One reason for this could be that these students are mainly motivated by the wish to study the programme. Taking exams and finishing courses therefore give immediate rewards. Students belonging to the **engineer-to-be** archetype however show an increased tendency to become low achievers. They do not leave the programme during the first year, but they are struggling with the courses and have problems keeping the set study pace. One reason for this could be that the goal for these students is more distant in time and that the everyday work with taking the basic mathematics, computer science and mechanics courses of the first year not always feels very motivating.

Conclusions and suggestions

This paper presents empirical results from a study on the motives and achievements of students on the master programme in Engineering Physics. Some general relationships have been found between students' motives and their achievements during their first year on the programme. It is however important to note that this study only covered one specific group of students during their first year on one specific five year programme at one specific university. However, our hope is that our findings will give inspiration for discussions on teaching and pedagogical development as well as for future research.

One issue we find worth focussing on is the observed difference in achievement between the two groups of student archetypes, **engineering-students** and **engineers-to-be**. The engineering-student has a good impression of the programme and often favourable experiences of previous physics studies. The goal of this student is however mainly in the present – studying the programme and doing well. The future career plan is often very

vague, but sometimes includes a general job possibly in the technical sector. The engineering-students generally succeed very well during the first year. The other major student archetype found is the engineer-to-be. The engineer-to-be is motivated by the prospect of becoming an engineer or having some other technical job. Sometimes the future career plans are quite detailed. The reason for choosing this specific programme is sometimes mentioned as previous experiences of physics. The engineer-to-be students exhibit problems with their achievement during their first year studies.

As the master programme in Engineering Physics is a vocational programme it would be reasonable to expect that both these student groups should succeed equally well. This study however shows that students mainly motivated by the short term goal of taking the programme succeed better during the first year than students with a long term goal of obtaining an engineering profession. This result highlights the importance of activities that focus on the future careers of the students during the first year. It also shows the importance of situating the basic courses of physics, mathematics and computer science in a larger context. That will make these courses appear more motivated by students with a different focus than just succeeding with the programme. Such efforts could also have the positive effect of broadening the views and motivations for the engineering-students who have a rather weak vocational focus. It is however important that this is done in a way which does not alienate the programme study focussed students.

“This is a university programme, not a preparation for life.”

Another issue of interest is that these results resonate well with the social and interactionalist models for student attrition as well as the broader perspective of Gees Discourse theory (2005). The different motives we see for the studied student population agree well with the idea of student identity. The motive patterns observed for the Uppsala students were significantly different to those found for the students at University of Cape Town. This clearly shows that students motives for enrolling into Higher Education is Discourse dependent, an issue that certainly warrant further discussion and investigation.

Previous studies of the relationship between student background and attrition from Higher Education have often focussed on such factors as gender, class, parents' academic background and earlier study results. In this study we have considered the motivational aspects within student identity and shown that these also play an important role for student achievement. This shows that the dynamics of student recruitment, achievement, attrition and retention is a quite complex issue that needs to be considered from many different perspectives.

Our hope is that this paper will inspire further research and pedagogical development as well as many fruitful discussions.

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References

- Andersson, S & Gelin, B. (2008) Avhopp från utbildningar i teknik och naturvetenskap vid Uppsala universitet, Uppsala universitet
- Braxton, J. M. & Hirschy, A. S. (2004) 'Reconceptualizing antecedents of social integration in student departure' in Yorke, M. & Longden, B. Retention and Student Success in Higher Education. Open University Press.
- Dick, T. P. & Rallis, S. F. (1991) Factors and influences on high school students' career choices, *Journal for Research in Mathematics Education*, 22, 281-292.
- Gee, J.P. (2005) An introduction to discourse analysis. Theory and Method. Second edition. London, Routledge.
- Jawitz, J & Case, J. (1998) Exploring the reasons South African students give for studying engineering, *International Journal of Engineering Education*, 14, 235-240.
- Johannsen, B.F. (2007) Attrition in University Physics. Licentiate Thesis, Uppsala, 2007
- Lave, J. & Wenger, E. (1991) Situated learning: legitimate peripheral participation. Cambridge, Cambridge University Press.
- OECD (2006). Evolution of Student Interest in Science and Technology Studies - Policy Report: Global Science Forum, OECD
- OECD (2008). Education at a glance - 2008, OECD
- Orvehed, M & Westman, P (2007) Nybörjarrapporten 2007, Uppsala universitet. (http://www.teknat.uu.se/internt/regelverk/#Information_studentrekrytering)
- Reed, B & Case, J. (2003) Factors influencing learners' choice of Mechanical Engineering as a career, *African Journal of Research in SMT Education*, vol. 7, 73-83.
- Robson, C. (2002) Real World Research, 2nd edition. Oxford, Blackwell publishing.
- Seymour, E. & Hewitt, N.M. (1997) Talking about Leaving – Why undergraduates Leave the Sciences. Oxford: Westview Press.
- Tinto, V. (1975) Dropout from higher education; a theoretical synthesis of recent research, *Review of Educational Research*, 45(1), 89-125
- Tinto, V. (1993) Leaving College: Rethinking the Causes and Cures of Student Attrition. Chicago: University of Chicago Press.
- Wenger, E. (2003) Communities of practice. Learning, Meaning, and Identity. Cambridge, Cambridge University Press.
- Yorke, M. & Longden, B. (2004) Retention and Student Success in Higher Education. Open University Press.