Surface Approachers Question Their Education

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Keywords: Approaches to learning, Computer science engineering education

INTRODUCTION

For the last ten years, out of a total of 1500 students who were admitted to the five-year Master of Science in Engineering in Computer Science (CS) at KTH - Royal Institute of Technology, only 20% graduated within the nominal study period + 1 year. Even though retention is low, employability is high: for 97% of the graduated students the education have lead to employment and 87% got employed already before graduation [1], which is a reason for the low retention.

In this study we investigated if students' approaches to learning in their penultimate semester of a master program in computer science engineering can be associated with their study results. The focus of the study can be concluded in the research question; whether students who graduate in time differ from their peers in terms of approaches to learning, study results or how useful they perceive skills learned during their education. For students' approaches we used the short version of Approaches and Study Skills Inventory for Students (ASSIST). For study results we used both finished Master's thesis, and graduation diploma.

1 BACKGROUND

1.1 Approaches to learning

Approaches to learning have been well researched and is widely used in higher education. The theory of approaches to learning derives from a qualitative analysis of students learning behaviour and intentions. With a focus on students search for

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meaning or not, the dichotomy deep/surface was identified, which has been the basis for the definition of deep and surface approach to learning [2]. By subsequent research a strategic approach to studying was added, related more to study behaviour than to learning process and can be explained as how to organize learning to do well in assessments [3][4].

Approaches to learning depends on context and content, in that students adapt their choice of approach depending on how they perceive and interpret a course or particular task [2][3]. They are not personality traits, but can be linked to different goals in forms of motivation [3]. Previous studies of approaches have generally investigated a single course; in this study we asked students to apply their answers to a generalized context to encompass their entire programme of study.

Most studies assume the prevalence of the deep/surface categories, but attempts have been made to form more distinct categories depending, for example, on discipline [5][6]. These have been qualitative studies. Case and Marshall's [6] construct has been confirmed [7], but only in a small sample of 19 students. [6] introduced two categories in addition to deep and surface approaches: a procedural surface approach where the intention is to pass the test but the strategy is problem-solving rather than memorisation and a procedural deep approach, that includes problem solving as strategy but with understanding as intention.

1.2 Approaches to learning and academic achievement

Previous research concludes that approaches to learning have an impact on the outcome of learning in terms of understanding, where high academic achievement has been positively related to a deep and strategic approach and negatively related to a surface approach to learning [8].

1.3 ASSIST

Approaches and Study Skills Inventory for Students (ASSIST) is an evolved revision of the Approaches to Studying Inventory (ASI) developed in the late 1970's [9]. In its short version, ASSIST is in an unembellished and manageable format, which makes it easily distributed and administered. It consists of 18 conceptually overlapping questions designed to allow the student to describe how they go about learning and studying. Responses are scored on a 1 – 5 scale, which forms three sub-scale score variables corresponding to the three study approaches. A high score in an approach means that the student exhibits the behaviour of it.

The questionnaire used in this study is a Swedish translation of the short version of ASSIST. The translated questionnaire has passed through a cross-cultural validation process by people independent from the project to improve the translation and to ensure consistency in wording and meaning with the original version. It has been revised to meet the requirement of internal reliability and have been tested in online and campus settings [eg.10].

2 METHOD

The short version of ASSIST was distributed via email as a web questionnaire to students towards the end of their penultimate semester on a master programme in computer science engineering. Based on previous experiences and due to the nature of the last semester, where most students execute their Master's thesis externally, the end of the penultimate semester was chosen in order to increase response rate.

In addition to the 18 ASSIST questions, we added five questions on their perception of studies and engineering regarding what they had learned, if they perceived this useful for their future career, the moment when they felt like an engineer, who and/or

what inspired them to become an engineer, and how they view their engineering future. The questions were inspired by a subset of a biannual career report that examines graduates work situation, career and their views of the education [1], in order to be able to compare previous students' perceptions with current students.

Data on their study results, including their Master's thesis, were gathered from registers at the university on two occasions: ten months after the questionnaire (four months after the nominal graduation date) and ten months after the nominal graduation date.

2.1 Statistical analysis

In order to get a more nuanced view of the item structure maximum-likelihood factor analysis with varimax rotation was performed. Number of factors to retain was calculated through the optimal coordinates index from non-graphical Cattell subjective scree test [11].

Spearman's *rho* was used to measure statistical dependence between variables.

3 RESULTS

3.1 Sample

Out of 161 students in total, 53 responded to the ASSIST questionnaire. No significant differences were found between the respondents and the study population, see *Table 1*. For both groups the median age was 24 years and the proportion of men was 94% for non-respondents and 87% among the respondents. Both groups had taken a mean of 286 ECTS credits during their years of study, with a mean of 306 ECTS for graduated students and 275 for non-graduates. Seven out of fourteen females responded, which gives a 50% response rate among the women but only 31% among men and 33% for the whole group, which is similar to course evaluations at KTH.

Table 1. Mean values and percentages for sample group and student group four and ten months after nominal graduation date.

		Respondents	Non-respondents	All
n		53	108	161
Males		87%	94%	91%
Grade Bachelor thesis		3.8	3.7	3.8
Grade Master thesis	Time 1	4.5	4.3	4.4
	Time 2	4.9	4.5	4.8
Master's thesis	Time 1	28%	36%	34%
	Time 2	58%	42%	47%
Graduated	Time 1	17%	29%	25%
	Time 2	34%	35%	35%

At the time of the first collection of graduation data (four months after the nominal date) the average student had at least begun their Master's thesis and 34 % out of all students had finished it (*Table 1*). Only 25% had graduated, a number that 6 months later had increased to 35%. For all students the mean grade for the Master's thesis was 4.5 and the median was a 5 (on a five-graded scale, with 5 being the highest grade possible).

3.2 Approaches to learning

Based on the 18 questions in ASSIST, four different factors were identified in the sample. As seen in *Table 2*, they were close to the original partition with a surface approach to learning (factor 1) and a mainly deep approach to learning, with an achieving element (factor 2). A difference could be found in two distinct strategic approaches: one without the organized studying part and with an element of inadequacy (factor 3) and one strongly organized form of strategic approach (factor 4).

Table 2. Spearman's *rho* for measure of association between approaches and found factors. p-value expressed by stars: * : p<0.05, ** : p<0.01, *** : p<0.001

	Deep	Strategic	Surface
Factor 1: Surface	-.36**		+.94***
Factor 2: Deep w achieving	+.98***	+.34*	-.38**
Factor 3: Strategic, unorganized		+.83***	
Factor 4: Strategic, organized		+.71***	-.34*

The motivation for the specifics in factor 2, 3 and 4 are not visible in *Table 2*, but are based on separate questions relevant to the factor rather than the whole predefined approach.

3.3 Academic achievement

Four months after the nominal graduation date 15 students had finished their Master's thesis with 16 more within ten months after. The students who did not finish their Master's thesis generally had a higher score on surface approach (p<0.05).

Nine students had graduated four months after the nominal graduation date and nine more ten months after. With a mean of 5.0 compared to 4.4, the 2nd group had an average higher grade on their Master's theses (p<0.05).

No correlation or association could be found between the grade on the bachelor thesis and Master's thesis or graduating.

3.4 Skills learned and their usefulness

Two of the added questions related to the learning at the university and the perceived usefulness of this. The first question was:

1. *Which of the following have you learned during your studies here?*

With the alternatives: Leadership, Societal perspective, Design, Solving real problems based on scientific and mathematical principles, Critical Thinking, Entrepreneurship, To work in groups, Ethics, Creativity, Communication, Problem Solving.

Table 3. Number and percentage of students who had learned each skill.

	yes	%
Problem solving	51	100%
Critical thinking	42	82%
To solve real world problems based on scientific principles	41	80%
To cooperate in groups	40	78%
Communicative skills	35	69%
Leadership	23	45%
Creativity	23	45%

Ethics	20	39%
Design	19	37%
Societal perspective	12	24%
Entrepreneurship	7	14%
Will find useful in future career	46	90%

The second question, which was related to the first, was:

2. *Are these things you think you will find useful in your future career?*

With the alternatives: Yes, No and if so, Why?

Two students did not answer these questions. One of them motivated it in the open answer alternative: “I did not choose any of the alternatives, since I do not consider myself to have mastered any of the alternatives to the extent that I personally feel that a student of this university should do”. In terms of accomplishments this could be considered an average student, he graduated and received grade 5 for his Master's thesis. He differed in that he had a low score in deep approach to learning as well as a high score in surface approach to learning. In addition to this he scored the lowest total score in organized strategic. He indicated Nobody as an engineering role model and was very stressed for the future.

Table 4. Spearman’s *rho* for measure of association between approaches and skills. p-value expressed by stars: . : p<0.1, * : p<0.05, ** : p<0.01, *** : p<0.001

	Surface	Deep achieving	Strategic, unorganized	Strategic, organized
Critical thinking		+ *		
Solve real world problems		+ *	+ **	+ *
Cooperate in groups	- .			+ *
Communicative skills				+ ***
Creativity				+ .
Ethics	- **			
Entrepreneurship				+ *
Useful in future career	- **			+ *
View of the future	- **			+ **

All students considered they had been taught problem solving during their education, *Table 3*. Nine out of ten thought that they would benefit from the skills taught during their education, although some commented the lack of practical exercises, such as deeper knowledge about field specific development methods and tools. The general consensus seemed to be that the theoretical knowledge acts as “gate openers” to an environment that otherwise felt off limit.

Students with a high score in surface approach to learning were less likely to consider these skills valuable for their future career (p<0.01), see *Table 4*.

3.5 Engineering and role models

The following two questions related to their perception of an engineer:

3. *When do you become an engineer?*

With the alternatives: At the admission, During the education, Upon graduation, After some time in the profession, Other.

46% of the students considered that they became an engineer during the education, 27% that it was when they graduated from the program and 27% after some time in the profession. Some of them commented that it was hard to pinpoint a specific time: it had more to do with attitude, maturity and experience.

4. *Who/what has shown you what an engineer does/is?*

With the alternatives: Teachers, Excursions to companies, Guest lecturers, By working in parallel with the studies or in the summer, Nobody, Other.

Table 5. Students' answer to Who/what has shown you what an engineer does/is.

	yes	%
Guest lecturers	21	40%
Teachers	20	38%
Working	18	34%
Nobody	13	25%
Excursions to companies	8	15%
Other	6	11%

Students with a deep approach to learning were more likely to have found inspiration from guest lecturers ($p<0.05$) while students with a surface approach to learning were less likely to have been inspired by lecturers ($p<0.01$). One third of students who had graduated choose Nobody, but the remainder of this group was more likely than other students to be inspired by lecturers. Students with organized strategic approach had been shown through a working experience ($p<0.05$).

Family or friends was not an option in the questionnaire, and was what those who chose other wrote in the comment section. If it had been an option, more students probably would have chosen this alternative, since it is commonly referred to as a contributing factor, but in our study this alternative was omitted due to a technical mistake.

3.6 View of future

The last question was a speculation on their future:

5. *How do you feel about the future after graduation?*

With a five-point scale going from stressed to calm.

There was no correlation between how students felt about the future and whether they had graduated or not. ⅓ of the students were calm about the future and this view also correlated with a high score in organized strategic approach ($p<0.01$). A high score in surface approach correlated with a stressed view of the future ($p<0.01$). Students who had learnt what an engineer does/is through a working experience had a calmer outlook about the future than those who answered Nobody ($p<0.01$).

4 SUMMARY AND CONCLUSIONS

Do students who graduate in time differ from their peers in terms of approaches to learning, study results or how useful they perceive skills learned during their education? The results show a positive correlation between a deep approach to learning and graduating in time and students with an organized strategic approach are more positive about the usefulness and range of skills learned during the education.

Students with a high score in surface approach to learning are stressed of the future. Furthermore, these students did not perceive the skills taught/learned during their education to be useful for their future career, in contrast to their classmates with strategic and deep approaches to learning. Educational follow-up questionnaires for alumni students have revealed that being able to adopt critical thinking, independent problem solving and collaboration/cooperation with others are a large part of their current working situation [1]. Areas where students with a high score in surface approach to learning correlate negatively, again in contrast to their classmates with strategic and deep approach to learning. Those who found the skills learned most valuable for their future careers were students with an organized strategic approach, which may be related to students in this group being more likely to have had a relevant working experience in the field.

Does this mean that those who adopt a surface approach to learning have missed the point of their education entirely, or is it the institution that has failed to motivate them? When these students get out in the field, will they find a meaningful employment that they can consider more interesting and relevant than their education? Or have they chosen the wrong subject of study and should be caught earlier on in order to present them with better alternatives? We aim to conduct a follow-up study with in-depth interviews to investigate the cause behind this and see if it is due to shortcomings in the learning environment, path of study, or incorrect or non-existent study techniques.

Employability for the programme is high, and with low retention this means that they can get work even without a degree. Their Master's theses are normally executed as an internship at an employer, which often result in recruitment before they finish their thesis or last courses. The shortage of CS-engineers makes the diploma less valuable. This factor should be further investigated, in order to be able to define and redefine what can be considered study success within this context.

Some variation in factor structure is to be expected between subject areas and the mismatch could either be due to specific learning processes in CS as a discipline or the need to rephrase questions in order to more accurately define a strategic approach in CS. Since this study builds on a questionnaire based not only on deep/surface approach to learning, but also on strategic approach, it does not confirm Case and Marshall's findings [6][7]. However, although the preconditions were different, this quantitative study could be used as further development of a disciplinary framework for approaches to learning in CS engineering. Further investigations with Booth's [5] four categories of approaches to learning in a programming context as well as Case and Marshall's [6] four dimensions of approaches to learning in an engineering context as supporting pillars would be gainful.

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