Are We Promoting a Surface Approach to Learning During the First Year of Engineering Educations?

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***Abstract*— The legislated goals for Master of Science in Engineering educations include goals like having the ability to critically, independently and creatively identify, formulate and handle complex problems as well as participate in research and development work and thus contribute to knowledge development. One might therefore argue that these educations are required to promote a deep approach to learning.**

This paper investigates to what degree new students at the Faculty of Engineering (LTH) at Lund University, Sweden, uses surface and deep learning approaches before being admitted and how these learning approaches changes during the first semester at our faculty. The questionnaire used- the Study Process Questionnaire designed by Biggs, was handed out to all new engineering students at LTH. The students were asked to answer the questions based on their experiences during their last year of studies before being admitted to LTH. After the first semester, the same group of students was asked to answer the same questionnaire based on their experiences during their first semester at LTH.

Of the 1106 new students 989 answered the first questionnaire (89 %) and 675 the second (61 %). 599 students answered both questionnaires (54 %). It can be concluded that the average student does not have a pronounced surface approaches to learning before being admitted to LTH. The use of a deep approach to learning was slightly more pronounced. After one semester at LTH there is a statistically significant decrease in deep learning approaches for both genders and for nearly all programs.

I. Introduction

The quality of university teaching can be judged by the quality of student learning it managed to support. The most widely used categories describing student learning are *deep approach* and *surface approach* to learning ([1], [2]). The former describes an attempt by students to construct complex and integrated knowledge related to an experience of personal meaning, while the latter has a focus on memorisation disconnected from personal meaning. Nowhere in the vast literature discussing these categories does surface approach lead to better understanding or problem solving skills. Deep approach is a better way to learn than surface approach. Thus, those higher education institutions that manage to encourage deep approach to studying among its students are better institutions, in terms of teaching.

However, two nuances deserve attention. 1) Deep or surface approaches are not directly related to visible ways of studying. Students engaged in rote learning or other ways of learning by heart could very well be engaged in deep approach to learning. The distinction between deep and surface approaches is more related to the degree of personal meaning than to visible behaviour [3]. 2) A third category of approach has been established, *strategic approach*, as researchers studied students in engineering [4], but has later also been described in relation to students in other areas. In this approach students are oriented towards success in terms of good grades and competition with other students. In this approach students are sensitive to signals from teachers about what is rewarded. Students using this approach are quick to adapt their study behaviour to what is encouraged by the teaching context; *non-strategic* student will not. Both these aspects of approaches to learning are important while interpreting student behaviour, but they do not affect the fact that students using a deep approach learn better.

We know from previous research that students self-reported study behaviour in secondary school is linked to success during their first year of studies. Kihl and Becker [5] showed that students who report that they during secondary school studied at home continuously during courses had a tendency to keep this behaviour while entering Lund University Faculty of Engineering (LTH) and that these students do better in mathematic courses than students concentrating their home studies closer to the exam. But we also know that students in first term engineering are strained by pace and amount of content and that students all to often revert to surface approach despite previous study-behaviour ([6], [7]). Arguably, and in line with what has been said above, changes in approaches to learning during the first semester at a university will offer some indication of the quality of teaching at the university.

Many different questionnaires have been developed with the aim of measuring students approaches to learning. The Study Process Questionnaire (SPQ) by Biggs [8] and the Approaches to Study Inventory (ASI) by Entwistle and Ramsden [4] are examples of extensively used questionnaires. Both these questionnaires, however, are rather demanding as the subject is expected to answer 42 (SPQ) and 64 (ASI) questions respectively. It is therefore not surprising that shorter, revised versions of ASI and SPQ have been developed.

The R-SPQ-2F questionnaire ([9]) is a revised version of SPQ that consists of 20 questions (see appendix) and focus on two factors only: deep and surface learning approaches. The score on deep learning approach and surface learning approach is obtained as the sum of the scores on individual items within respective category:

- Deep learning approach = 1+2+5+6+9+10+13+14+17+18
- Surface learning approach = 3+4+7+8+11+12+15+16+19+20

Subscales (motive and strategy) for both factors exists, but Justicia et al. [10] recommend not to use of strategy and motive as subscales for the two approaches when using R-SPQ-2F. The scores that are obtained from R-SPQ-2F on the two learning approaches (deep and surface) are integers in the range 10 to 50, where 10 suggests that the student has no tendency of adopting the learning approach in question and 50 that the student has fully adopted the learning approach.

The aim with this study is to investigate how the teaching at the Faculty of Engineering influences the learning approaches of the first year students. The following hypotheses were set up as a starting point:

1. The learning approaches of the newly admitted students vary from year to year.
2. Newly admitted students of different gender have different approaches to their studies.
3. The teaching at some programs influence the students towards more surface approach and other programs towards more deep approach to their studies.

II. METHOD

In this study, a printed copy of the R-SPQ-2F questionnaire was given to all first-year engineering students at the Faculty of Engineering, Lund University. In order to measure the change in approaches to study during their first year, the questionnaire was given to all 1120 students admitted to five-year engineering programs at the faculty 2010 both in August during their first week after admission and in January 2011, when they had finished their first semester at the faculty. In the August questionnaire they were asked to base their answers on how they approached their studies in their last year of studies before being admitted to the faculty and in the January questionnaire they were instead asked to base their answers on how they approached their studies during their first semester at the faculty. To study changes in approaches to learning, results from the January questionnaire was compared on an individual level with the August questionnaire. The questionnaire was also given to all students admitted to engineering programs 2011 in August 2011 in order to get an indication whether or not there are large variations between students admitted different years.

The response rate in August was as high as 89% in 2010 and 95% in 2011 (Table 1). The lower response rate in January 2011, 61%, is partly due to student drop-out as 61 students (5.5%) had either officially terminated their engineering studies or were on an approved leave from their studies at the time. The number of students answering the questionnaire both in august 2010 and in January 2011 was 599 (54 %).

Both in August 2010 and January 2011 all students who responded wrote their names, gender and program on the surveys. By using the combination of name and program it was possible to create a unique, random identifying number that was included in the database instead of the name of the students. This identifier made it possible to compare results from January 2011 with August 2010 on an individual level. In August 2011 some students left the fields name, program and gender blank when responding to the survey. Out of the 1152 answers in August 2011 we thus have information on gender for 1065 and on program for 1115 student answers.

As the data were not normally distributed, Non-parametric tests were used for testing the significance of changes and differences. For differences in scores between different groups of students, the Kruskal-Wallis H-test “kruskalwallis” in Matlab was used. For changes in scores, paired data coming from the same student at different points in time, the Wilcoxon signed rank test “signrank” in Matlab was used.

III. RESULTS

The average scores from August 2010 and 2011 are remarkably similar on faculty level (Table 1) and Kruskal-Wallis tests could not reject the hypothesis that they have the same median with respect to Deep Approach (DA), Surface Approach (SA) and DA-SA. With average scores for SA of 20.9 and 21.0 for new students 2010 and 2011 respectively (Table 1) it seems that the average admitted student has not adopted a surface approach to learning. Scores for DA are markedly higher (31.2 and 31.5) than for SA, but not high enough to support the claim that the average admitted student has clearly adopted a deep approach to learning. Evaluating the level of deep or surface approach by comparing with studies from other countries is difficult e.g. since the students’ understanding of the questions might be culturally dependent.

TABLE 1.
Student responses to R-SPQ-2F. August results relate to students perception of their learning approach during the year before being admitted to the Faculty of Engineering and January results relate to their learning approach during their first semester at the Faculty of engineering.

Admitted	Date	N	Responded	Responded twice	Learning Approach (Scale 10-50)		
					Deep (DA)	Surface (SA)	DA-SA
2010	Aug 2010	1106	989 (89%)	599 (54%)	31.2	20.9	10.3
2010	Jan 2011	1106	675 (61%)		28.0	22.6	5.4
2011	Aug 2011	1218	1152 (95%)		31.5	21.0	10.5

Average scores are remarkably similar also on program level (Table 2 & 3) between August 2010 and August 2011. Only three cases of significant changes on program level were found using Kruskal-Wallis (Table 3). As regards differences between programs in August 2010, no significant differences between programs were found with regard to SA score and only one program had a significantly larger DA score than three other programs (Table 2). For August 2011, one program had a significantly larger DA score than one other program and one program has a significantly larger SA score than three other programs (Table 3). It thus seems that the variation between years is small and in the same order of magnitude as the variation between programs.

TABLE 2.
Results for students admitted 2010 to different programs. Biomedical Engineering started in 2011 and is thus not represented in this table. Kruskal-Wallis test found significant differences as indicated by superscripts of the same letter, e.g. DA Aug 2010 for Engineering Mathematics is significantly different from DA score for three other programs. Wilcoxon signed rank test found significant changes where indicated by †.

Program	N	Aug 2010				Jan 2011			
		Responded	DA	SA	DA-SA	Responded	DA	SA	DA-SA
Biotechnology	68	61 (90%)	31	21	11	42 (62%)	27†	23	4†
Computer Sci.	126	119 (94%)	31	20	11	76 (60%)	27†	23†	4†
Chemical Eng.	54	45 (83%)	31	22	9	35 (65%)	27†	24	3†
Civil Eng.	109	104 (95%)	32	21	11	69 (63%)	28†	23	5†
Electrical Eng.	100	96 (96%)	32	20	12	67 (67%)	28†	23†	5†
Eng. Physics	93	71 (76%)	32	20	12^{C}	50 (54%)	28†	22	7†
Eng. Mathem.	43	26 (60%)	35^{A}	20	14^{B}	25 (58%)	30†	21	9
Environm. Eng.	69	65 (94%)	31	20	12	43 (62%)	28†	22	6†
Ind. Man. Eng.[1]	106	103 (97%)	30^{a}	22	8^{b}	66 (62%)	28†	22	6†
InfoComm [2]	42	36 (86%)	32	22	10	21 (50%)	30	22	9
Surveying	60	60 (100%)	30^{a}	21	8	37 (62%)	29	24	6
Mechanical Eng.	151	132 (87%)	30^{a}	22	8^{bc}	87 (58%)	28	22	7
-”- Ind. Design [3]	31	28 (90%)	32	21	11	21 (68%)	26†	24	2†
Nanoscience	54	43 (80%)	31	21	10	36 (67%)	28†	23	5†

1) Industrial Engineering and Management
2) Information and Communication Technology
3) Mechanical Engineering with Industrial Design

TABLE 3.
August 2011 results for students admitted 2011 to different programs. August 2010 results for students admitted 2010 (see Table 2) given as comparison within parenthesis. Kruskal-Wallis test between programs denoted as in Table 2 and significant changes between years marked with †.

Program	Responded	DA	SA	DA-SA
Biotechnology	62	32(31)	19^{b}(21†)	12^{C}(11)
Computer Science	134	32(31)	20^{b}(20)	12^{C}(11)
Chemical Eng.	62	31(31)	21(22)	10(9)
Civil Eng.	117	31(32)	21(21)	10(11)
Electrical Eng.	86	33(32)	22(20)	10(12)
Eng. Physics	70	33(32)	20(20)	13^{C}(12)
Eng. Mathematics	39	32(35)	21(20)	12(14)
Environm. Eng.	62	33^{A}(31†)	20(20)	13^{C}(12)
Ind. Man. & Eng.	113	32(30†)	22^{b}(22)	10(8)
InfoComm	44	30(32)	22(22)	9(10)
Surveying	64	29^{a}(30)	23^{B}(21)	6^{c}(8)
Mechanical Eng.	141	31(30)	21(22)	9(8)
-”- and Design	28	32(32)	21(21)	11(11)
Nanoscience	54	32(31)	21(21)	11(10)
Biomedical Eng.	39	32	20	13^{C}
(blank)[1]	103	30	21	10

1) Students that did not specify to what program they were admitted.

On faculty level (n=599, see Table 1), changes in scores (DA, SA, DA-SA) between August 2010 and January 2011 were found to be significant by Wilcoxon signed rank test. This was also the case when changes were analysed for male (n=426, see Table 4) and female (n=173) students separately. Compared to August 2010, the January 2011 scores clearly indicate a tendency towards applying less deep and more surface learning approaches on all programs and for both genders. It should be noted that for January 2011 scores, no statistically significant differences were found between programs (Table 2) or between genders (Table 4). The students' approaches to learning are thus more similar after the first semester.

On program level changes in DA scores between August 2010 and January 2011 were significant for 11 programs (Table 3) but for SA scores changes were significant only for two programs. The tendency to move away from deep approaches thus seem more pronounced than the tendency to adopt a surface approach to learning during the first semester, at least when analysed for groups of students.

TABLE 4.
Scores for students responding both in August 2010 and in January 2011 to R-SPQ questionnaire with respect to gender. Kruskal-Wallis test results denoted with letters a-c (A-C). Wilcoxon signed rank sum test shows that all scores (DA, SA, DA-SA) change significantly between August and January for men and women.

Gender	Responded (twice)	August 2010			January 2011		
		DA	SA	DA-SA	DA	SA	DA-SA
Female	173	31.9^{A}	20.5^{B}	11.5^{C}	27.4	22.7	4.7
Male	426	31.2^{a}	21.1^{b}	10.1^{c}	28.2	22.5	5.7

Since the students so kindly supplied information that allow us to pair the data from August 2010 and January 2011 the changes in scores can also be analysed on the level of the individual. The cumulative distribution of changes on the individual level (Figure 1, Lower) clearly illustrates the shift towards a surface approach. If we set the limit for a large change to ±10 on DA and/or SA we see that a large increase in SA is more common than a large decrease in SA and the other way around for DA:

- 36 students (6%) decrease their SA-score by at least 10, while 81 (14%) increase theirs by at least 10
- 35 students (6%) increase their DA-score by at least 10, while 127 (21%) decrease theirs by at least 10
- 57 students (10%) increase their DA-SA score by at least 10, while 200 (33%) decrease theirs by at least 10

It should be noted, however, that this tendency to shift towards a surface approach does not in any way imply that each and every individual shift towards a surface approach. The variability on the level of the individual is considerable (Figure 1, Upper). Some shift towards a surface approach, others towards a deep approach and still others remain rather unaffected in their approach to their learning by the first semester at the faculty.

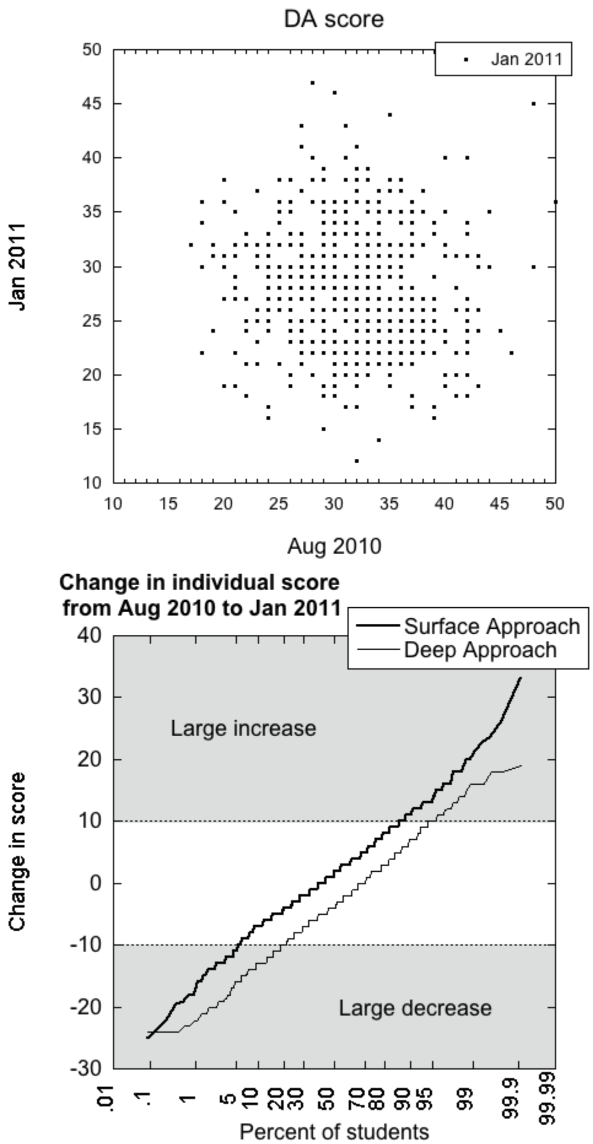

Fig.1. Upper: Scatter plot of DA score on individual level August 2010 and January 2011. Lower: Cumulative distribution function of change in DA and SA scores on individual level.

IV. FINAL REMARKS

In our results, there is a clear tendency towards surface approach to learning during the first semester. Rather than fostering a deep approach to learning it seems like the first semester at the faculty encourages a surface approach to learning. This is worrying and raises a number of questions: Is a surface approach to learning promoted in the assessment of the students? Is the change towards a surface approach a trend that continues throughout the education or just a temporary setback? To what degree is the student approaches to learning influenced by other factors than our teaching (like workload for students, contact time between teachers and students, changes in social and economic factors etc)?

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APPENDIX

Study Process Questionnaire (R-SPQ-2F) (from Biggs, 2001)

Name:____ Education Program:_________

When you answer the questions below you should do so based on how you experienced your last year of studies (in secondary school/university or similar) before you started at the School of Engineering at Lund (the wording was different on the second questionnaire after one semester of studies at the School of Engineering)

	Fill in the appropriate square that best corresponds to your immediate answer to the question	Never or rarely true	Sometimes true	True about half of the time	Frequently true	Always or almost always true
1	I find that at times studying gives me a feeling of deep personal satisfaction.	☐	☐	☐	☐	☐
2	I find that I have to do enough work on a topic so that I can form my own conclusions before I am satisfied.	☐	☐	☐	☐	☐
3	My aim is to pass the course while doing as little work as possible.	☐	☐	☐	☐	☐
4	I only study seriously what's given out in class or in the course outlines.	☐	☐	☐	☐	☐
5	I feel that virtually any topic can be highly interesting once I get into it.	☐	☐	☐	☐	☐
6	I find most new topics interesting and often spend extra time trying to obtain more information about them.	☐	☐	☐	☐	☐
7	I do not find my course very interesting so I keep my work to the minimum.	☐	☐	☐	☐	☐
8	I learn some things by rote, going over and over them until I know them by heart even if I do not understand them.	☐	☐	☐	☐	☐
9	I find that studying academic topics can at times be as exciting as a good novel or movie.	☐	☐	☐	☐	☐
10	I test myself on important topics until I understand them completely.	☐	☐	☐	☐	☐
11	I find I can get by in most assessments by memorising key sections rather than trying to understand them.	☐	☐	☐	☐	☐
12	I generally restrict my study to what is specifically set as I think it is unnecessary to do anything extra.	☐	☐	☐	☐	☐
13	I work hard at my studies because I find the material interesting.	☐	☐	☐	☐	☐
14	I spend a lot of my free time finding out more about interesting topics which have been discussed in different classes.	☐	☐	☐	☐	☐
15	I find it is not helpful to study topics in depth. It confuses and wastes time, when all you need is a passing acquaintance with topics.	☐	☐	☐	☐	☐
16	I believe that lecturers shouldn't expect students to spend significant amounts of time studying material everyone knows won't be examined.	☐	☐	☐	☐	☐
17	I come to most classes with questions in mind that I want answering.	☐	☐	☐	☐	☐
18	I make a point of looking at most of the suggested readings that go with the lectures.	☐	☐	☐	☐	☐
19	I see no point in learning material which is not likely to be in the examination.	☐	☐	☐	☐	☐
20	I find the best way to pass examinations is to try to remember answers to likely questions.	☐	☐	☐	☐	☐