

Differences in perceptions of studies between cohorts of engineering students

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This paper draws on a larger longitudinal study and is based on 1775 questionnaire responses from five questionnaires and students in four cohorts of students in Applied Physics and Electrical Engineering. Two cohorts studied in a traditional setting whereas two cohorts followed the CDIO curriculum. The research questions concern differences in perceptions of workload, opportunities to cooperate, influence and interact with teachers between cohorts and over time. The first three cohorts perceived the workload as heaviest in the third year and the last cohort during their fourth year. Female students experienced heavier workloads than male students, but an interaction effect showed that females of last two cohorts experienced lower workloads than the first two cohorts. Studying in groups peaked during the third year. Later cohorts consistently experienced better opportunities to cooperate with peer students. Opportunities to influence the studies and having contacts with teachers increased over time and the last cohort had best such experiences. The last cohort experienced a stable pattern of significantly less social isolation, while the other cohorts experienced more variation and more social isolation. Students identified themselves more, were more proud of studying and had more faith in the quality of the program over time.

Keywords: Longitudinal study; Workload; Cooperation; Social Isolation; Project Course

Introduction

Ten years ago, a larger longitudinal cohort-study with an overall purpose of comparing expectations and experiences of four cohorts of students in Applied Physics and Electrical Engineering was initiated [1] The focus has been on self-reported aspects in areas such as perceived workload, opportunities to cooperate, opportunities to influence, social isolation, and belief in the quality of and identification with the program [2, 3, 4, 5]. In 2002 a new approach to education was introduced. Students would from the start work in project groups, involving more scheduled time working together with other students in small groups, which differs quite a lot from the previously more traditional form of education based very much on individual achievement and big lectures. The results are based on a total of 1775 questionnaire answers from five questionnaires from four cohorts that started the program in 1998, 1999, 2000 and 2002. In this paper, the focus is on differences in perceptions of workload, opportunities to cooperate, influence and interact with teachers, identity with the program, social isolation and thoughts of dropping out between cohorts and over time.

Theoretical framework

According to Candy and Crebert [6] the emphasis in higher education is upon personal achievement, ambition, goals, and most essentially, personal rewards. However, when

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students graduate and become members of an organization, the opposite applies as team achievement, team goals, and team results are fundamental to the success of the organization. Candy and Crebert [6] states that “adjusting from being an introverted, isolated student who guarded knowledge and research jealously to an extroverted, gregarious team-member who shares the benefits of personal knowledge and research often provides psychological, social, and learning difficulties for the new employer” (p. 583). This may be one of the reasons for implementing the CDIO syllabus, and especially the project courses. Project based learning generally means that the students and the supervisor, within certain frames, chose how they manage the project and take positions on various issues in the project, such as content, process and organization [7]. Being able to cooperate and to work productively as a team member is very important in most organizations.

Students who focus on learning and mastery of the subject matter (mastery oriented) are more fitting to show continuous engagement with schoolwork than performance oriented students according to Ames [8]. Project Based Learning designs emphasize on student autonomy, collaborative learning, and assessments based on authentic performances. These features can maximize students’ orientation towards learning and mastery. According to Blumenfeld et al. [9] Project Based Learning also involves variety, challenge, student choice that aim at promoting students’ interest and perceived value. Students in project based learning apply what they learn to solve problems and make decisions. Boaler [10] has shown that such learning is regarded as more flexible than knowledge acquired in more traditional didactic teaching methods. In another study, Boaler [11] found that students who had studied with a traditional method experienced mathematic work as boring and tedious, while students at a project-based school regarded mathematics as a dynamic and flexible subject that involved exploration. Students in the project based school performed significantly better than students in the traditional school on national examinations [12]. The reason for the difference was according to Boaler that students in the project based school were taught with a progressive and open model that developed more flexible and practical forms of knowledge that they could use in a variety of settings.

In other words, research has found several benefits by designing project based courses. In project based learning, there is usually a good linkage between learning principles and their applications, and students may be allowed to be more creative than in traditional learning settings [12, 13] and to grasp the material [14]. In an experimental study, Waks and Sabag [15] found that students who studied in technology project based learning improved more and achieved significantly better than students in a control group. Their conclusion was that the project environment facilitated learning that contributed to improvements of the students’ achievements. The authors discuss that the explanations for their results may be that there was an open atmosphere in the project based course and that the projects benefited a constructionism approach to learning.

Feeling socially isolated can be associated with the setting of the students, e.g. not feeling comfortable in an academic world despite having good relations in other settings. It can also be associated with social relations, for instance when there are difficulties to establish contacts with other students. The central sensation of social isolation is often feeling of not truly fitting in. Research has shown that social integration, which involves the structural aspects of social relations, is more important for most students than academic integration [16]. Lack of real or perceived social support and networks is a significant reason for student drop-

outs [17]. Support from teachers has been found to be necessary for increasing the social integration of the students in courses [17]. Weidman et al. [18] claims that perceptions of opportunities to influence the study situation and opportunities to interact with teachers can contribute to increased engagement in the studies and feelings of affinity.

The changes that have been introduced in the program between 1999 and 2002 resulted in cohort 2002 being the first one to have a project course, which was compliant to the CDIO philosophy already the first year. Cohorts 2000 did its first one in the third year. The project courses have two main purposes: (a) students shall learn a project management model called LIPS (Lightly Interactive Project Management Model). The LIPS model has been developed at Linköping University and indicates how a project should be structured and managed. It specifies that the phases of the project contain a number of *tollgates* and *milestones* the project group must pass as the project is carried out; (b) students shall learn how to collaborate in a project group during a limited amount of time. Students are supposed to actively manage their own education and work according to the LIPS project model. Furthermore, the project group has a social dimension that can have a decisive influence on students' decisions to continue in the program [7]. Research has shown that if correctly organized, project based learning increases study motivation [19], student engagement in investigating authentic problems [9], and creates a high degree of teamwork [7]. A vast number of studies show that identification with a program or a university can have an impact on the students' willingness to invest in their time and engagement in their education [18].

Method

Participants

Four cohorts of students in a 4.5-year Applied Physics and Electrical Engineering program participated in the study. Students from the four cohorts enrolled in the program in 1998, 1999, 2000 and 2002. The students were asked to voluntarily participate in the study. No questionnaire was coded and students were anonymous.

Design and Measures

Five questionnaires were distributed to the four cohorts on five different occasions. All questionnaires cover several areas regarding students' experiences and perceptions of various aspects of their studies (e.g. working hours, perceived workload, influence on study the situation, cooperation with teachers and peer students, social isolation, identity with and belief in the quality of the program and thoughts of dropping out of the program. The first questionnaire concerns students' experiences and perceptions of the first semester in the program and was distributed in class at the beginning of the following semester. The following two questionnaires concern the first and the second year in the program and were distributed in class at the beginning of the semester after the year that the questionnaire focus on, while the last two questionnaires concern the third and the last year in the program and were distributed by mail at the beginning of the semester after the year that the questionnaire focus on.

Table 1. Response frequency for the five questionnaire and cohorts 1998, 1999, 2000 and 2002

Cohort	Q1	Q2	Q3	Q4	Q5
1998	137 (79%)	120 (75%)	77 (57%)	76 (64%)	62 (52%)
1999	155 (81%)	107 (64%)	75 (50%)	65 (47%)	43 (33%)
2000	159 (98%)	125 (83%)	82 (64%)	47 (40%)	39 (34%)
2002	145 (98%)	134 (97%)	56 (46%)	42 (40%)	30 (40%)
Total	596 (88%)	486 (79%)	290 (54%)	230 (48%)	174 (38%)

Table 1 presents the response frequency for all questionnaires and cohorts of the study. Within the parentheses, the percentage of responses of all enrolled students in the particular year and cohort is presented. It is clear that the response frequency is reduced in the second and third questionnaire. One reason for the decreased response rate can be that for students who had the questionnaires distributed to their homes were not as inclined to return completed questionnaires as students in the lecture.

In certain calculations, the two earlier cohorts (1998 and 1999) have been merged into one group and the two later cohorts (2000 and 2002) have been merged into another group.

Results

To determine how the four cohorts experienced their real, average corking hours per week during the first semester and the four years in the program, percentages of students in each cohort and each questionnaire who had worked more than 40 hours per week were calculated.

Table 2. Students' estimations of their real, average working hours per week

Cohort	More than 40 hours/week %				
	Q1	Q2	Q3	Q4	Q5
1998	29	42	47	66	39
1999	32	41	45	67	19
2000	21	19	39	51	24
2002	28	31	36	43	50
Total	27	33	42	60	28

Students' estimated personal average working hours per week are presented in Table 2. More students of cohorts 1998 and 1999 worked more than 40 hours per week throughout the program, except for year four. By then, cohort 2002 had the greatest amount of students who worked more than 40 hours per week. For the other cohorts, it is clear that the greatest amount of students who worked more than 40 hours per week was found in the third year. No significant differences were found, apart from the fourth year, in which a much greater amount of students from cohort 2000 worked in groups. Over time, the students worked more and more in groups.

Perceived workload, on the other hand, is not always the same as the actual hours that students work. The correlation between perceived workload and actual working hours was only .59. In the survey, the students could indicate their perceived workload on a 5 point

scale, from small to overwhelming. In Table 3, the amount of student who answered that their workload was very heavy to overwhelming from each cohort is presented.

Table 3. Amount of students who experienced their workload as very heavy or overwhelming for all cohorts throughout their studies in the program

Cohort	Q1 %	Q2 %	Q3 %	Q4 %	Q5 %
1998	22	24	20	46	11
1999	25	27	17	63**	2
2000	23	16	12	47	11
2002	13	17	22	18**	23*

Note * = $p < .05$, ** = $p < .005$

The workload was perceived as heaviest during the third year for cohorts 1998 to 2000. For cohort 2002 a different pattern was obtained as their workload was less heavy the third year, but instead the heaviest during the fourth year. During the third year, significantly more students of cohort 1999 perceived the workload to be very heavy or overwhelming and significantly fewer students, only 18 percent, perceived the workload as very heavy, $\chi^2 (6, N = 228) = 22.14, p < .005$. During the fourth year, a significantly greater number of students in cohort 2002 perceived the workload as very heavy, $\chi^2 (6, N = 168) = 8.16, p < .05$.

When the mean values of perceived workload were compared, an interaction effect on sex was obtained. Female students of cohorts 2000 and 2002 consequently perceived the workload to be more moderate than female students in cohorts 1998 and 1999, see Figure 1.

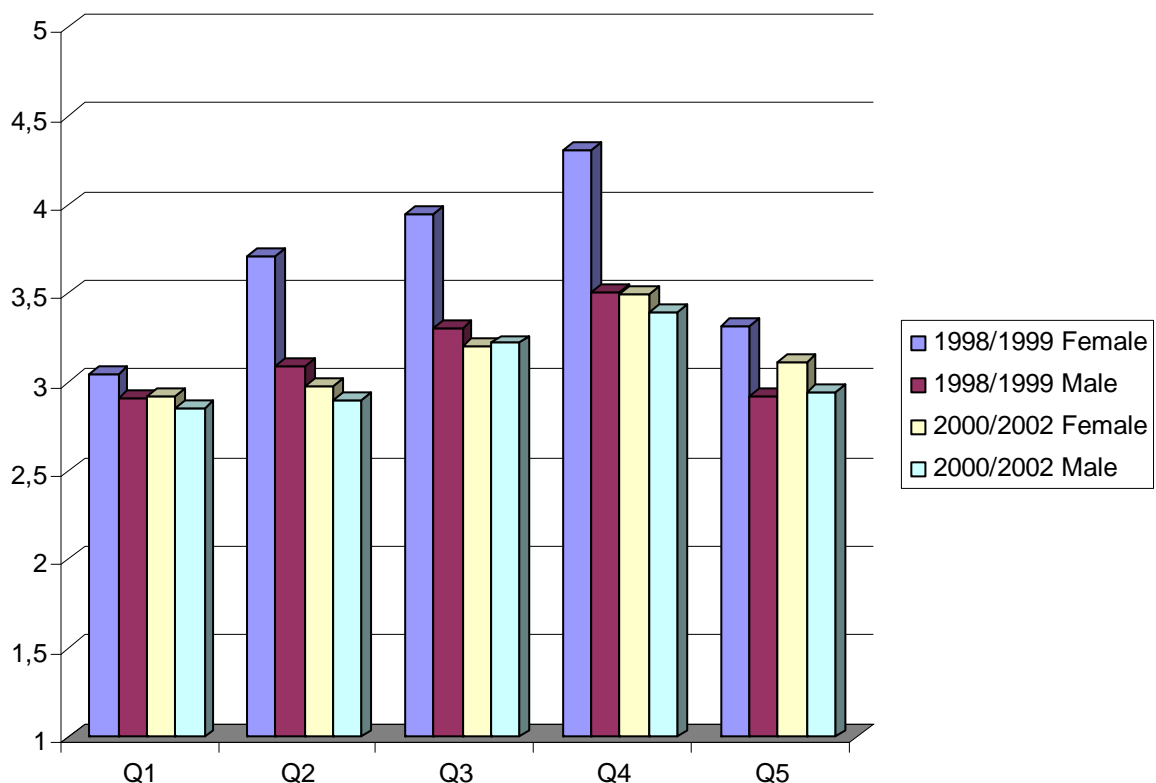


Figure 1. Perceived workload (mean values) among female and male students, cohorts and questionnaires

In general, these cohorts perceived the workload to be heavier than cohorts 2000 and 2002, and female students perceived the workload as heavier than male students. However, the interaction effect shows that except from year 4, female students of cohorts 2000 and 2002 perceived the workload as less heavy than both male and female students of cohorts 1998 and 1999 ($F(1, 1707) = 15.77, p < .001$).

To summarize, a different pattern was obtained for cohort 2002 than for the other cohorts. In the fourth year, they had a greater amount of students who worked more than 40 hours per week and who perceived the workload as very heavy. The other cohorts, and especially 1998 and 1999, had such experiences in the third year.

Influence and cooperation

Students were also asked how they spend their time while studying (whether they use most of

Table 4. Students' estimations of the amount of time they studied in groups

Cohort	Q1	Q2	Q3	Q4	Q5
1998	-	-	18	24	19
1999	-	-	19	22	22
2000	12	12	16	18	28
2002	15	16	16	19	20
Total	14	14	17	24	22

their time in scheduled time, individual work or group work). In table 4, the average amount of students who study in groups is presented. The percentage of students who study in groups augmented during the third and fourth year in the program. In order to see if the students also experienced that their cooperation with peers had been fruitful, a factor analysis was carried out with items measuring cooperation, student influence, and teacher contact. Two factors were obtained; Factor 1, which is called *Cooperation with peer students*, and Factor 2, which is called *Influence and teacher contact*. The two factors explain 30 and 54 percent of the variation for Q1, Q2, Q3, Q4 and Q5. The factors were extracted using a principal component analysis. The result was rotated using varimax.

Factor 1 contains the following items:

- I think that the cooperation with peer students has been rewarding
- I have had rewarding and stimulating interactions with peer students out of class

Factor 2 contains the following items:

- I have good opportunities to influence my study situation
- I have a rewarding and stimulating contact with the lecturers
- I have a rewarding and stimulating contact with the lesson assistants
- I have a rewarding and stimulating contact with lab assistants

The factors can have values between 1 and 5 (1 = bad experiences of cooperation, influence and contacts). The results indicate that students in cohorts 2000 and 2002 experienced better opportunities to cooperate with peer students than students in cohorts 1998 and 1999.

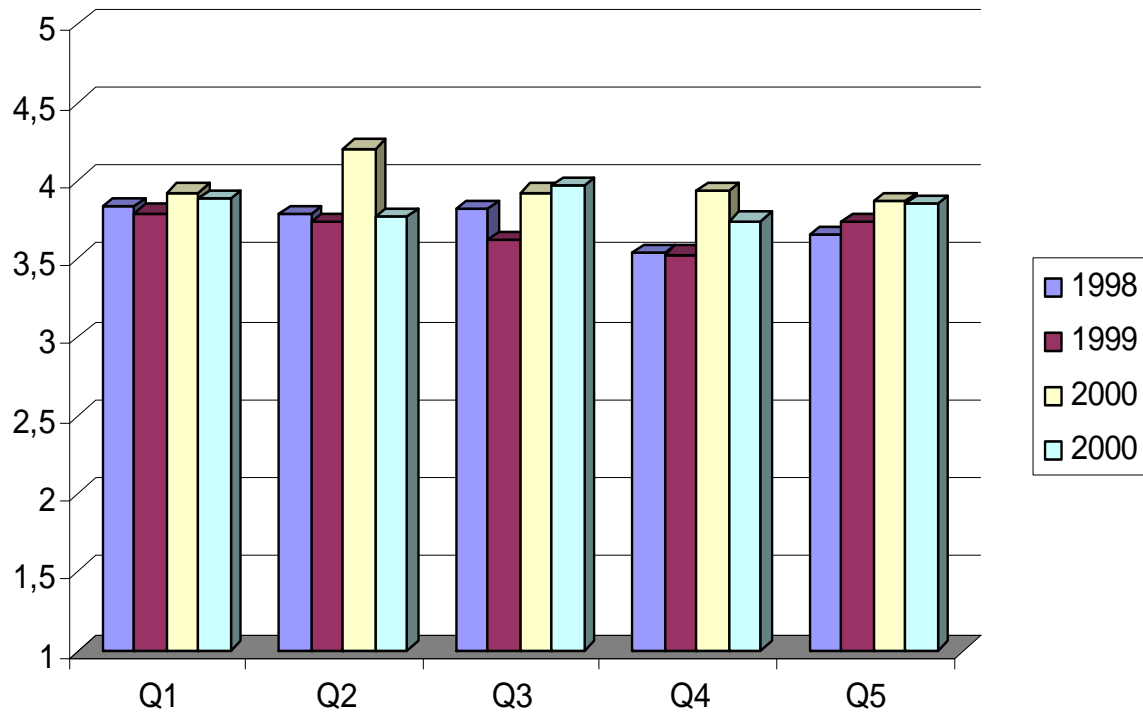


Figure 2. Cooperation with peer students, mean values divided on cohorts 1998, 1999, 2000 and 2002

There was no significant main effect on time, but the tendency was that cooperation was experienced as most rewarding during the first two years, and decreased in the third year, and then ameliorated again in the fourth year. Cohort 2002 experienced their cooperation as most rewarding in the second year, 4.2, which was the highest mean score of all cohorts and questionnaires. In Figure 2, this result is clearly presented in a diagram.

An additional analysis was made with two groups; group 1 with cohorts 1998 and 1999, and group 2 with cohorts 2000 and 2002. A significant difference was obtained for the first factor. Students of the second group consistently experienced their cooperation to be significantly more rewarding, $F(1, 1765) = 11.3, p < .001$. This result is presented in Figure 3.

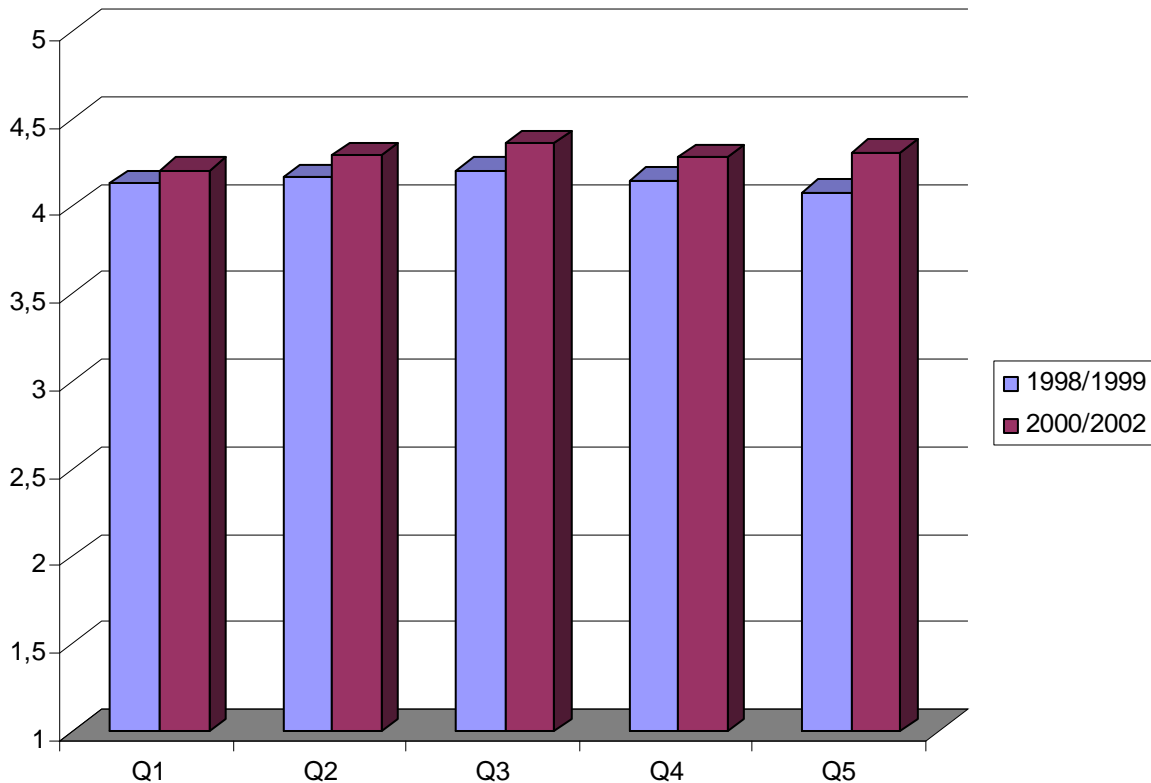


Figure 3. Cooperation with peer students, mean values divided on cohorts 1998/1999 and cohorts 2000/2002 for each questionnaire

All cohorts experienced their opportunities to influence their study situation as rather good. However, the mean value was below 3 at four times. Cohort 1999 obtained the mean value 2.78 the first semester and 2.82 the second semester, and 2.91 the third year in the program, and cohort 2000 obtained 2.95 the second year. Consequently, a significant difference was obtained for cohort 1999 who experienced their opportunities to influence and interact with teachers as worse than the other cohorts, $F(3, 1737) = 6.76, p < .001$. A main effect on time was obtained, as experienced opportunities to influence and having contact with teachers increased over time, $F(4, 1737) = 11.52, p < .001$.

An additional analysis was made with two groups for the second factor as well; group 1 including cohorts 1998 and 1999, and group 2 including cohorts 2000 and 2002. A significant difference was obtained for the two groups; group 2 (cohorts 2000 and 2002) experienced better opportunities to influence and interact with teachers, $t(1735) = 2.88, p < .005$.

No main effect on sex was obtained. On the other hand, there was an interaction effect for time of measurement and sex. During the first year, female students experienced their cooperation with peers as more rewarding than male students, but during the following three years, male students experienced their cooperation as more rewarding than female students, $F(4, 1713) = 3.43, p < .01$.

Identity and belongingness

A factor analysis of the items about "identity, belongingness, and evaluation of quality" resulted in two factors. Factor 1 can be called *Affinity and pride*, and factor 2 can be called *Belief in the quality of the program*. These two factors explain 45 % and 68 % of the variation. The factors were extracted using a principal component analysis. The result was rotated using varimax.

Factor 1 contains the following items:

- I have feelings of affinity with the program and the University
- I am proud to study in the program
- I have really come to the right place

Factor 2 contains the following items:

- I am oriented about research at the various departments of the program
- I believe the departments of the program have a high quality in their research

In Table 5, mean values for Factor 1, Affinity and Pride, are presented. The scale can have values between 1 and 5 and 1 means the least feelings of affinity and pride.

Table 5. Students' feelings of identification with the program and pride of studying in the program. In the Table, mean values are presented

Cohort	Q1	Q2	Q3	Q4	Q5
1998	3.82	3.81	4.00	3.93	3.85
1999	3.76	3.65	3.74	3.86	3.81
2000	3.75	3.73	3.86	3.92	3.96
2002	3.85	3.65	3.62	3.96	3.82
Total	3.80	3.71	3.80	3.92	3.86

An analysis of variance showed a main effect on time; over time, students more and more identified themselves with the program and were prouder to study in the program, especially during the third and fourth year, $F(4,1737) = 3.87, p <.05$. The students had the strongest identification with the program in the third year, which coincided with the peak in perceived workload, sleeping problems and social isolation.

In Table 6, mean values for Factor 2, Belief in the quality of the program, are presented. The scale can have values between 1 and 5 and 1 means the least beliefs in the quality.

Table 6. Mean values of students' beliefs in the quality of the program

Cohort	Q1	Q2	Q3	Q4	Q5
1998	3.09	3.33	3.54	3.53	3.42
1999	3.18	2.93	3.39	3.63	3.52
2000	3.04	3.18	3.37	3.46	3.33
2002	3.07	3.35	3.15	3.43	3.33
Total	3.10	3.20	3.38	3.52	3.40

For factor 2, there was a main effect on time and an interaction effect. Over time, students' belief in the quality of the program increased and peaked in the third year, $F(4, 1727) = 19.7$,

$p < .001$. Mean values for both factors were in general quite high, especially for identification with the program (mean values between 3.62 and 3.92), which indicated that students feel affinity and pride and believe in the quality of the program.

Social isolation and thoughts of dropping out

In Figure 4, the amount of students who experienced social isolation to some degree throughout the program is presented.

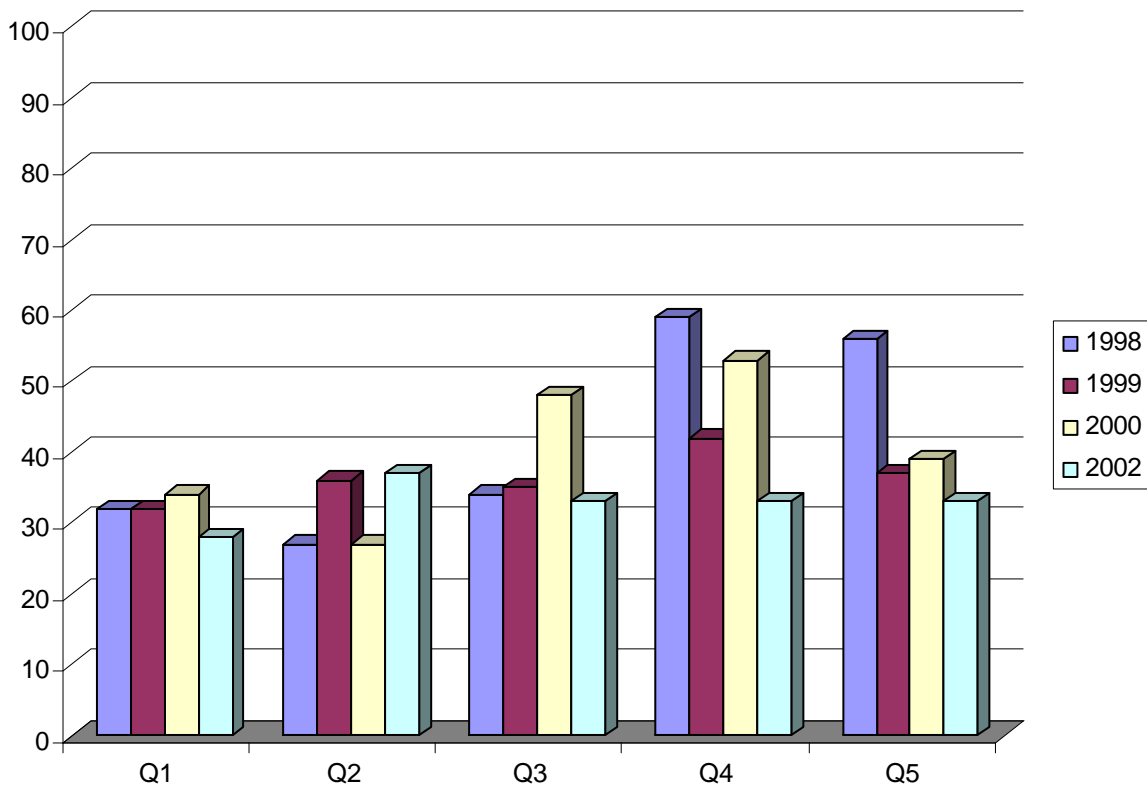


Figure 4. Amount of students in each cohort who, to some degree, experienced social isolation throughout their studies in the program

Students of cohort 2002 both had the greatest amount of students experiencing social isolation in the second semester and the smallest amount of students with such experiences during the following three years in the program. The amount of student who experienced social isolation to some degree was 33 percent from the second year and onwards. The respective amount of the other cohorts increased to a much higher degree during the third and fourth year in the program. It is evident that more students of cohort 1998 experienced social isolation than the other cohorts during these two years. A χ^2 -test showed that cohort 1998 experienced significantly more social isolation and cohort 2002 experienced significantly less social isolation during the third year, $\chi^2 (3, N = 227) = 9.0, p > .05$.

In Table 7, the amounts of students who have had thoughts of dropping out of the program are presented. Cohort 1998 had the smallest amount of students with thoughts of dropping out of the program while cohort 2000 had the greatest amount of students with such thoughts. This

difference was significant in the second year, $\chi^2 (3, N = 288) = 43.4, p < .001$, the third year $\chi^2 (3, N = 212) = 32.9, p < .001$, and the fourth year $\chi^2 (3, N = 132) = 25.7, p < .001$.

Table 7. Amount of students of the four cohorts who have had thoughts of dropping out of the program during the various times of measurement

Cohort	Q1 %	Q2 %	Q3 %	Q4 %	Q5 %
1998	40	37	22	20	14
1999	32	30	22	17	10
2000	43	41	28	15	8
2002	39	41	30	24	23
Total	37	38	25	19	13

The amount of women with thoughts of dropping out was greater than for men in general, $F(1, 1704) = 17.2, p < .001$. However, an interaction effect on cohort and sex was obtained. During the first two years, there were fewer female students of cohort 1999 had thoughts of dropping out and in the third and fourth year, the amount of women with thoughts of dropping out was smaller than for men in cohort 2000 and cohort 2002, $F(3, 1704) = 3.3, p < .05$. Over time, the amount of students with thoughts of dropping out decreased significantly, $F(4, 1750) = 17.43, p < .001$.

Discussion

Development over time

Six main changes were discovered over time. Perceived workload increased throughout the programs with peaks in year three and four. Studying in groups increased with peaks in year three and four, but cooperation was perceived as less rewarding in year three. Perceived opportunities to influence the study environment and to have contacts with teachers improved over time. Pride and beliefs in the quality of the program increased over time with a peak in year three. Finally, thoughts of dropping out of the program decreased over time.

An explanation for these results is that the third year was more demanding for the students. This result has been found in earlier studies in this project [3], which explains the perceived increase in workload. The increased time spent studying in groups in the third year may have been a necessary strategy to cope with the high demands and the heavy workload. However, it seems as if the high demands and the heavy workload had a negative impact on how rewarding the cooperation was perceived to be. Furthermore, there is another explanation for the findings regarding perceived opportunities to influence the study environment, contacts with teachers, pride and beliefs in the quality of the program, and of dropping out. As students continue in the program they have by the third and fourth year invested both a lot of time and energy in their studies. Consequently, they think less of dropping out, they get to understand the system of higher education and better know how to influence their study environment and how to contact teachers when needed. The closer they come to obtaining their degrees, their pride and their beliefs in the quality of the program increases. This may be explained by the psychological term cognitive dissonance. According to this theory, as effort expended increases, enjoyment of the task increases [20]. Consistent with this theory, Marsh and Roche [21] found that classes that were perceived as being more difficult, moved at a faster tempo, and required a heavier workload were associated with higher student evaluations of teaching.

In our results, the students' beliefs in the quality of the study program and their pride were highest in the third year when the workload was perceived as heaviest. Students may have justified their spend effort in the third year and at the end of their studies, they justify all their effort during all years throughout the program. However, an alternative explanation may be that the students chose to devote more effort to more enjoyable courses in the third year. A third explanation may be the decreased response rate. The students who answered the last two questionnaires were probably highly successful students, and they had few thoughts of dropping out, they perceived their opportunities to influence and to have contacts with teachers as better. Students who succeed in a program further seem to be more liable to believe in the quality of the program.

Differences between the cohorts

Previous studies have indicated that there are many benefits for students to study in project based courses compared to more traditional teaching approaches [12, 13, 14, 15]. The present study looks at other aspects of student experiences and perceptions of their studies and these findings indicate that there are more benefits from studying in project based courses than only achievement related ones.

Five main differences were obtained between the cohorts. Cohort 2002 had a different pattern than the other cohorts as regards real working hours and perceived workload while cohort 1999 perceived their workload as significantly heavier than the other cohorts. Cohort 2002 experienced less social isolation during the last two years than the other cohorts. Cohorts 2000 and 2002 experienced better opportunities to influence their studies, to cooperate with peer students, and having contacts with teachers than cohorts 1998 and 1999. Cohort 2000 had more students with thoughts of dropping out than the other cohorts.

The main explanation for these differences may be that cohorts 2000 and 2002 studied in CDIO-based projects group. Both these cohorts studied in project courses but cohort 2000 had their first project course in their third year whereas cohort 2002 already had had experiences of such courses and where used to that form of studying. This may explain why 18 percent in cohort 2002 and 47 percent in cohort 2000 perceived the workload as very heavy to overwhelming. Cohorts 2002 may have been more used to experiencing deadlines, cooperation with peer students and work according to LIPS.

As regards the difference in perception of workload in the third year, cohort 1999 may have had a different strategy, whereby they tried to manage all their courses in their third year, while the other cohorts tried to spread out their efforts over the third and fourth year. Cohort 2002 seems to have been better prepared to work in project groups in the third year and thus may have perceived the workload as less heavy.

A hypothesis concerning the different experiences in social isolation is that the program board had intentions to prevent the new cohorts from the negative experiences that especially cohort 1998 had but also cohort 1999 experienced to some degree in the beginning of their studies in the program. These intentions seem to have had an effect on cohort 2002, who enrolled in the program when quite a few interventions had been introduced. It is notable that cohort 2002 experienced social isolation to a significantly lesser degree than cohort 2000, as interventions had been introduced for both of these cohorts and both studied in project based courses in the

third year. One reason for the different experiences in social isolation between the two cohorts may be that the students in the two cohorts mean different things with social isolation [cf. 17].

The cohorts who studied in project based courses experienced better opportunities to influence their study environment, to cooperate with peers and to have contacts with teachers. A hypothesis is that the project courses had a positive impact on the students' experiences of cooperation with peers, opportunities to influence the study environment and having contacts with teachers. This is in line with research that has found that project based learning increases opportunities to cooperate [9]. Furthermore, Boaler's findings that project based learning helps students to feel that mathematics is a dynamic and flexible subject [11] may both improve their opportunities to cooperate with peers and to have fruitful contacts with teachers. When a subject is experienced as more dynamic and flexible, it may also result in increased perceptions of opportunities to influence the studies.

The findings that show differences between the cohorts who studied traditional courses and the ones who studied in project based courses may also be explained by different cultures in the cohorts. The program in Applied physics has a long tradition as a prestigious program and students who enroll usually expect high demands and a heavy workload [4, 5]. When the interventions were introduced in the program in 1999 and continued during several years, there may have been a change in culture in the program. Students who enrolled in 1998 and 1999 expected traditional teaching and heavy workloads and whereas students who enrolled in 2000 and 2002 may to a larger extent have expected a less heavy workload, more project based courses and more opportunities to cooperate with peer students. These new expectations may result in a new culture in the program that has an impact on the patterns of cooperation with peers and teachers, their experiences of social isolation, and their opportunities to influence their study environment.

Cohort 1998 had the smallest amount of students with thoughts of dropping out of the program while cohort 2000 had the greatest amount of students with such thoughts. There are two possible explanations for this finding. The first one is that more students in cohorts 1998 dropped out of the program at an early stage in the program. In cohort 2000, there were more efforts to have good retention rates in the program. Thus, the students who remained in the 1998 cohort were the ones who were determined to stay in the program and graduate, whereas more students who were not as determined to stay in the program and with lower beliefs in their capabilities still studied in the program several semester later on. The second explanation may be that there has been a change in attitudes between the cohorts.

There are several limitations to these findings, however. First, all the student perceptions and experiences were measured with a self-report instrument. Self-reports can be used effectively to measure student perceptions of e.g. motivation [22] but are not measures of what happened, but of what participants believe happened. Thus, reliance on these measures can be deceiving and need to be replicated with other measures, such as structured interviews or behavioral measures. In the current study, semi structured interviews have been used, and results from them do to some extent support the findings of this study [4, 5]. In addition, the response rate decreased from quite high in the first questionnaires to not so good in the last few questionnaires. Since the respondents were anonymous, an analysis of the decrease in response rate is not possible. There is a risk that the reduction of responses is systematic and that students who answered the questionnaires differ from students who chose not to do this.

The heterogeneity among the cohorts will therefore decrease over time, and students who answered the questionnaires will be more homogenous over time, and the results will to a great extent refer to 'the successful' students. This could imply that there is a bias in some of the results. However, as the results on e.g. perception of workload, cooperation with peer students and teachers, and social isolation to some extent are in line with the findings of two previous longitudinal studies [4, 5]. Thus, the results should be interpreted with some caution, but most of them seem to be rather representative of what the students in Applied physics and electronics. Clearly, more research is needed on the relationships between on the one hand the perceptions of workload, social isolation, cooperation with teachers and beliefs in the quality of a study program and on the other hand the design of courses, i.e. whether they are designed in a more conventional way or as project based courses.

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