Can One ECTS Credit Make All the Difference? Comparisons of the Actual Student Workload versus the Credit Inflation

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ABSTRACT

How large impact does one ECTS credit have on the student motivation and effort? In this paper, we compared the results from learning environment data and post-course questionnaires between three different years of the same introductory programming course to gain insight on the perceived workload from a student's point of view. While the teaching material and required assignments for successfully completing the course stayed mostly the same apart from minor scheduling tweaks, the reward for completing the course was raised from 5 ECTS credits to 6 ECTS during the observation period. According to our statistical analysis, the difference in student perception of the course workload in relation to the reward was insignificant: Even though the reward was higher in the latter years and passing requirements were mostly the same, the students' assessment of the workload and their course activity did not change or did not lead to better results. This indicates that the sixth credit may have been lost to the credit inflation caused by the revised curricula, and that the one extra credit does not increase the overall motivation towards the course to a large degree. This also implies, that from the viewpoint of providing more educational content, offering several small courses might be more efficient than offering few large course modules.

CCS CONCEPTS

• **Social and professional topics → Professional topics;** *Computing education*; Student assessment

KEYWORDS

Curriculum, course workload, grade inflation

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1 Introduction

With increased student volumes, the teaching methods have to adjust towards self-oriented approaches, and the curricula in general adapts to the needs and realities of the available teaching resources [1]. In some situations, this leads to the strategy of repackaging the taught subjects into larger mass-course modules, which if nothing else, streamlines the bureaucratic process behind the course management, since there are numerically fewer courses to manage. However, this activity has the unbeneficial side-effect of grade and degree inflation [2-3], which have several root causes, but the oversimplification of the curricula is amongst of them. Also in general, the student workload has been reported to be on downward cycle in several universities and colleges [21].

In this paper, we study the effect of grade and study point inflation against the actual workload of the students, with three mostly identical courses. The first one is a five credit course and second is a six credit course extending the five credit course. Additionally, we present the data from the same six credit course arranged the following year with some changes in place, to put the comparison of the two different ECTS rewards in better context. The research questions are 1) how to measure the incentive of ECTS reward to student effort, and 2) how a revised reward affects students' perception of course workload. These questions are important since many European universities use the ECTS system as a common quantifier for measuring the volume of studies, and many times students plan their own study schedules based on factors, which include course sizes. Curricula sizing is therefore an important part of software engineering education on all levels, from undergraduate to graduate and doctoral programs.

To answer these questions, this work presents a case study where the students' results, the effort required to complete coursework, and perceived course workload from an introductory programming course are analyzed. The study was conducted by comparing student data from two iterations of the first programming course (CS1): The first group of respondents took the course in 2015 and were asked to evaluate their own workload when they received 5 ECTS credits for completing the course. The same course was arranged in 2016, where the passing requirements and course material stayed the same with 2 more weeks to accomplish everything, this time awarding 6 ECTS credit points We also compare the differences of the 2015 and 2016 course versions with the latest iteration of the course in 2017.

We accumulated data from three sources: The virtual learning environment (VLE) (see [4]) was used to gather the data on the time used for individual assignments. Coursework grading provided the performance ratings, while the post-course self-assessment questionnaires were used to survey how well the students thought the courses ECTS volume and workload estimate correspond to actual time used for completing the coursework.

This study is also a continuance work to our previous studies into the student motivation and activities during the programming courses. In our prior work, we have studied for example collaborative learning [5], student plagiarism networks [6] and the impact of online-enabled course content to the intrinsic motivation [7]. In this study, the objective is to assess the effect of incentive-based motivation, by comparison of two course implementations which share similar features, faculty, student population and content, but the other course offering one additional study point because of minor changes to the course curricula and the overall study program structures.

The rest of the article is structured as follows: Section 2 discusses related existing studies, and the research process is explained in the Section 3. Section 4 has the results, which are discussed in the Section 5. Section 6 summarizes the paper with the conclusions.

2 Related studies

It is an established fact that in software engineering in general, and especially in education, motivation is the key for achieving progress and enhanced results (for example [8-10]).

In a study by Forte and Guzdial [8], the introductory course for computer science was tailored for the audiences in an attempt to increase the student interest towards the topic, while simultaneously minimizing the number of withdrawals and failed final grades. In their work the first programming course was offered in three versions: the traditional introductory course, a course tailored for the engineering students, and a course tailored for other non-computer science disciplines. The results were reflective of the motivational aspects: in the courses where the content was tailored towards the audience backgrounds, the key indicators implied minor improvements in the motivation, and major improvements in the final grades.

In purely motivational aspects, the different technical solutions such as robots or game-like design for added motivational push has been studied. For example McGill [9] applied personal robots and robotics in the fundamental courses in programming. Although not novel concept (for example [11]), the robot programming was considered an important aspect for the student motivation to learn programming. In the study, McGill observed that even though developing programs with an actual robot increased the attention of the students towards the course, it had minimal or neutral impact on the satisfaction, confidence or relevance factors, which were the other measured attributes. This result is partially supported for example by McWhorter and O'Connor [12]; if the motivational aspect fails, the robots do not provide meaningful amounts of other improvement factors.

Games as the motivation tactics was studied by Jiau et al. [10]. Their approach was to include algorithm optimization exercises as a game development task and problem-solving challenge. In their study, they report significant improvement on the student outcomes and course results by applying this technique, a similar observation that was also applied in the development of the Alice learning tool for object-oriented programming [13].

The intrinsic student motivation is an important aspect of the course outcomes, but the other aspect of motivation is the incentive-based motivation [14]. As based on a meta-analysis conducted on a large population of volunteers, Cerasoli et al. [14] observed, that the intrinsic motivation is most effective on the highly professional and specialized work, whereas the incentive-based motivation is more effective on repetitive and low-level and straightforward assignments. Similar observations on the effects of extrinsic rewards has been made also by for example Gagné and Deci [15]. Following these concepts, in the fundamentals-level learning assignments where the level of customization and analyzation is low, and the personal interest towards the subject is not guaranteed, the students should respond to the incentive-based motivational aspect positively, and it should have a meaningful impact.

3 Research process

The course Introduction to Programming was used as a test case in our experimental setup. The course spans the fall semester, consisting of 12 to 14 weeks of lectures, programming exercises, a 50 hour programming project and midterm exams or a separate final exam. The original course was designed to minimize the amount of so-called hygiene problems (see [16]), the small annoyances which hinder the actually productive work by causing interruptions and unnecessarily rising the learning curve, and to promote the student motivation over the course coverage, deferring advanced topics such as the memory management or pointers to the following advanced courses. The original design and implementation work is documented in detail in the publication by Nikula et al. [17].

An opportunity to study the effect of the incentive-based motivation came possible, when the course curricula was revised to follow a standard of 6 ECTS/course structure in replacement of the 5 ECTS/course structure our university followed earlier. The change on the amount of given credits required the course syllabus to include 27 hours of extra work from the students, to justify the addition of one ECTS course credit. In practice, the added hours to the course plan caused main difference between the two implementations to be that the 6-credit implementation ran two weeks longer, had two additional lectures on ancillary topics, and two additional sets of exercises replacing the voluntary extra assignments from the 2015 implementation. The requirements for grades stayed the same in 2016, even though the course lasted for an additional two weeks during which previously extra credit only weekly exercises and additional lecture material was covered.

Essential learning goals also remained the same throughout the comparable years. In 2017, the weekly assignments and programming project were developed further to better fit the ECTS sizing, and therefore we were unable to use the data from the latest iteration of the course for statistical analysis. However, we can use the descriptive indicators from 2017 in comparison to the last two years to establish context beyond examining the difference between single years.

Overall, on both 2015 and 2016 implementations the final grade was based on the separate grades from the exam, exercises and the project work. The courses organized in 2015 and 2016 were identical in the expected minimum effort, and the effort needed to receive the best possible grade. Additionally, even though the amount of students on the course rose from previous in 2016, the student body was still very homogenous, as all the students for whom the course is mandatory came from degree programs in technology and engineering.

The two student populations from the courses were compared against each other to test whether the groups were statistically similar. This was tested with chi-squared test [18] to establish that the two groups and their course performances were independent variables, ie. that the probability to pass the course was not affected by the participation year and that the groups were similarly capable. The chi-squared test concluded that the groups were independent with results being independent variables with the confidence level below $p<.01$. Therefore, the student samples were not correlating with the participation year or possibility to pass the course, and the 2015 and 2016 metrics could be compared against each other. Table 1 presents the course activities and planned online and offline workloads, which are intended to represent the time and effort an average student spend throughout the course, with the Table 2 summarizing the student average effort. The other statistical data was collected from the learning environment used to collect and autograde assignments (see [17]) and from the student surveys conducted at the end of the course. From these data, the collected information was analyzed with the Mann-Whitney U test to evaluate the difference in distributions between 2015 and 2016. The test was selected because it is suitable for the independent sample, non-parametric data [19].

Table 1. Outline and offline workload estimates for the case courses.

	2015 (5 ECTS)	**2016 (6 ECTS)**	**2017 (6 ECTS)**
Lectures (offline, not mandatory)	24 h	28 h	28 h
Tutoring / recitation groups (offline, not mandatory)	24 h	28 h	28 h
Reserved for completing the programming exercises (online, mandatory 25% completion)	35 h	40 h	40 h
Reserved for completing the programming project (online, mandatory)	45 h	50 h	50 h
Exam and midterm (mandatory)	3 + 3 h (paper and pen)	3 + 3 h (online)	3 + 3 h (computer classroom exam, not online)
Reserved for other independent self-study such as preparation to the exam	-	10 h	10 h
Total expected work hours online	80 h	96 h	90 h
Total expected work hours for the course (1 ECTS = 27h of work)	135 h	162 h	162 h

Table 2. Descriptive statistics from the studied cases

	2015 (5 ECTS)	**2016 (6 ECTS)**	**2017 (6 ECTS) ****
Total students (enrolled)	325	527	545
Survey respondents (N)	116 (36%)	182 (35%)	103 (19 %)
Average online time (hrs) per user	61,8	78,6*	55.8
Average online time (hrs) per user without online exams	61,8	75,7	55.8
Median online time (hrs)	52,3	58, 8*	50.1
Median online time (hrs) without online exams	52,3	56,3	50.1
Course work started	287	454	523
Passing grades (Pass-%)	249 (76.6%)	374 (70.9%)	380 (69.7 %)
Average grade from the project (median)	3,86 (5)	3,09 (4)	3.49 (4)

*includes the online exam which was used in 2016 only.

**in 2017 the course assignments and project were different.

4 Results

In this section the different results and metrics collected from the activity logs are presented. First of all, the Mann-Whitney U test was applied to assess whether the two courses (2015 and 2016) had significant differences between the reported time distribution and sessions activity based on the VLE data logs. After applying sanitation measurements of rejecting students with less than 30 hours of recorded activities, and compensating the 2016 group for the online exams which weren't available for the 2015 course, the H0 hypothesis of "The distribution of total hours is the same across categories of course year" was retained, despite the averages and medians being higher. Median time used in 2016 was 58.78 hrs, and 52.25 hrs in 2015; the distributions in the two groups did not differ significantly (Mann-Whitney U=50591.5, n1=454, n2=287, P > 0.05). In comparison, the median online time in 2017 was 50.12 hrs.

Similarly, the student activities were tracked based on their weekly submitted exercise assignments during the course. This data indicates, that the activity patterns are almost identical, with most of the students working similarly on both courses during the first half, and dropping off at the latter part of the course, with the larger 2016 course having a small increase in activity during the weeks 10-14. This data is summarized in the Table 3..

Finally, the student activity and the perceived workload was assessed with the student feedback. The student feedback survey covered topics such as the perceived workload and difficulty of the course, grading of the different course components and also open feedback on how the course could be improved. Overall, the results indicate that the sixth credit given on the 2016 course did not affect the student performance, workload or motivation to a large degree. The results are summarized in Table 4.

Overall, the student feedback did not differ to a large degree between the courses, although the trend was that the 5 ECTS course was considered better by the student feedback; the appropriateness and overall grades for the 2015 implementation were both over 4 (in scale 1-5, 5 best), whereas in the 2016 course they were half a grade worse. Similarly, the amount of positive feedback declined in the 6 ECTS course, although this can be explained also with the technical problems concerning the online exams and the learning environment. On the assessment of the amount of effort, the self-assessed perceived workload actually declined somewhat, but the difference between the implementations (from 3.1 to 2.9) is not very meaningful. In contrast, the workload was perceived as much higher the in 2017. The amount of student feedback about the workload and required effort increased between 2015 and 2016, and the 2017 course collected significantly more feedback about the amount of work than either of the previous years.

Table 3. Weekly activity of the students; the student completed all exercises during this week

	2015 (5 ECTS)	2016 (6 ECTS)	2017 (6 ECTS)
Week 1	262 (81% of all)	405 (77% of all)	477 (91% of all)
Week 2	273 (84%)	440 (84%)	436 (83 % of all)
Week 3	274 (84%)	434 (82%)	400 (76 % of all)
Week 4	249 (77%)	399 (76%)	316 (60 % of all)
Week 5	216 (67%)	336 (64%)	329 (63 % of all)
Week 6	204 (63%)	339 (64%)	256 (49 % of all)
Week 7	167 (51%)	272 (52%)	385 (73 % of all)
Week 8	227 (70%)	357 (68%)	280 (53 % of all)
Week 9	210 (65%)	281 (53%)	83 (16 % of all)
Week 10	86 (27%)	169 (32%)	136 (26 % of all)
Week 11	87 (27%)	182 (35%)	122 (23 % of all)
Week 12	95 (29%)	224 (42.5%)	185 (35 % of all)
Week 13	4 (1%) (elective, same as week 14)	140 (27%)	90 (17 % of all)
Week 14	4 (1%) (elective, same as week 13)	46 (9%)	31 (6 % of all)

5 Discussion and implications

Obviously there are limitations to the collected data, and elements presented in the results. For example, the survey instrument changed between the years to prompt more descriptive feedback, and the wording of the question has changed over time. However, in all the feedback surveys questions used the Likert scale of 1 to 5, and asked the students to evaluate how the actual course workload compares to the ECTS sizing of the course. The average grade from these questions was not very different between the years (3.1 in 2015, 2.9 in 2016). Additionally, as the statistical analysis shows, the answers are not statistically significantly different from each other.

In all years the course workload and insufficient credits are some of the most highlighted themes students gave feedback about, especially if ignoring technical details such as bugs in the learning environment or exercises. It should be noted though, that in 2017 the survey included a separate open-ended question about the perceived course workload, which may explain the high number of negative workload related feedback in that year. Additionally, even though our VLE system has an automatic 30 minute inactivity logout feature for the sessions left open, a handful of students recorded very unrealistic hundreds of hours of online activity. These clear outliers were sanitized, and due this issue the median values were applied in the overall analysis.

The student body for whom the course is mandatory is very heterogenic, as it covers almost all undergraduate engineering

Table 4. Metrics collected from the course ending survey.

	2015 (5 ECTS)	2016 (6 ECTS)	2017 (6 ECTS)
Amount of survey responses / open feedback left (% of total)	117/69 (41%/24%)	182/114 (40%/25%)	103/53 (20%/10%)
Appropriateness of the teaching methods. (1-5 grading, 5 best)	4.3	3.7	3.4
Overall grade for the course (1-5 grading, 5 best)	4.1	3.5	3.4
How much time did you use on this course? (1 much less than estimated, 3 estimate, 5 much more than estimated)	3.1	2.9	3.9
Amount of positive feedback	24 (34.7%)	13 (11.4%)	14 (26%)
Amount of negative feedback about the workload	11 (15.9%)	24 (21.0%)	34 (64%)

students in the university. Additionally, most students take the course during their first year of studies. This is a limitation in the sense that the freshmen have few other courses to compare the workload with, and may for that reason have difficulty estimating the real hours they have had to invest.

The usage statistics from the VLE platform provide some insight to the actual working hours of students. The statistical analysis indicated that the time usage was similar between the years, even if the 2016 statistics exhibit about 7 hours more median online working time, most likely caused by the online exam, which was added to the 2016 course. Regardless of the reason, from a teacher's perspective the same learning goals were achieved using the same amount of time or even slightly more. In 2017 the average and median online working time was again similar to 2015, this time in a course setting which had been altered for the specific reason of adding more content for the new ECTS sizing. These numbers suggest at least partial credit inflation, as the students are passing the same course with the same learning goals but getting a higher reward for their efforts. In addition, since the relative amount of negative feedback on the workload increased for the 2016 course, and also in 2017, it can be said that the incentive of extra credit did not provide much of a difference in our case.

In general, it seems that the incentive-based motivation of one additional study credit probably does not translate into actual work effort of 27 hours. As based on our observations, the student workloads do not differ to a large degree between the five and six credit effort. The grade averages actually fell by one grade when the course was revised to become a larger module; it seems that the students were content with getting a worse passing grade, instead of putting more effort into the course. This observation is in line with the observations on the college-level student time usage and effort reported in [21]. Even if we did not observe the offline work hours, the student performance and course outcomes does not imply that there would have been a meaningful difference, especially since the populations and their performance results were statistically comparable. In the grand picture, this also implies that the students receive 20 percent larger reward for their effort, since for the Master's degree, the students are required to take in average 50 completed 6 ECTS modules instead of 60 completed 5 ECTS modules. As based on the workload estimations from our case study, it could be argued that the approach with 60 modules with 5 credits provides better learning outcomes, and the one ECTS course credit difference in the default module content scaling imposes the risk of the difference of ten modules in the Master's degree curricula. This translates to the issue that on the long run, almost one year worth of studies could be lost to the credit inflation, similar to the grade [2], and college degree [3], inflation.

Considering the entire curricula, the results here are an interesting observation on that the larger, topic-spanning courses are not as efficient as smaller topic-oriented courses, especially if the course can be successfully completed with a subset of information not covering the entire content. One suggestion on why this happens is that since the students can optimize their effort during the course, they can simply select to submit works where the assignments are relatively easier to compensate on the added topics which tend to be more difficult. In our case, the only more active weeks on the 2016 course were during the weeks 10 to 12, where there were 10 to 15 percent more activity. However, it is worthwhile to observe that getting 25 percent of the mandatory assignments completed is possible within the first 5 weeks of the course. If the students are willing to accept worse final grades, like our students based on the median grades did on the 2016 course, they are not actually required to do extra work on the latter part of the course.

6 Conclusions

In this paper we have presented the results of our study into the incentive-based motivation in the student participation activity and studied the effect on a course implementation, where the only major differences were the two additional weeks of lectures, and one additional study credit.

Based on our observations, the answer to the research questions 1) how to measure the incentive of ECTS reward to student effort, and 2) how a revised reward affects students' perception of course workload can be summarized as follows: one credit difference does not translate to the student motivation or workload in a meaningful manner. There were no indications that the one-point difference, or the two extra weeks of the course had a meaningful impact since the only actual difference was 7-hour increase in the median, which could also be explained with minor changes in the course arrangements. Even though the 7-hour increase in online working time between 2015 and 2016 could indicate that the students were in fact working more and the rest of their active work was completed offline (which we could not measure), we could see from the 2017 course data that the average and median working times came down again. Additionally, it is worth noting that if the students' working time was on the rise, the additional reward in credits would still be lost in inflation, as the course's key learning goals stayed the same throughout the years.

Similarly, as reported elsewhere [20], the students usually optimize their time usage to minimize the required effort. The amount of mandatory work being a percentage of all assignments during the course translates to the problem where the amount of needed extra effort to get the sixth credit does not require 27 hours of extra work. This problem can be summarized as follows: if the students can select the weeks and topics on which they spend the needed extra time, completing two extra assignments in the earlier, easier part of the course allows them to skip the two weeks' worth of added content on the latter part of the course.

In our observed cases, the sixth ECTS was lost to the credit inflation, meaning that the extra credit was awarded with no additional learning activities required from the student, and no extra learning objectives achieved. On a scale of a degree program, this inflation-caused small difference would mean that the student with an average of fifty 6 ECST modules would be a full semester worth of knowledge behind the student, who did sixty 5 ECST modules, while technically receiving the same degree from the same program.

Obviously there are also risks in this study; the amount of independent self-study was not measured, and the activity logs were inaccurate to the degree that some sanitation had to be done. However, the statistical analyses indicated that the results between the courses were identical, as were the worktime and activity estimations. Even though there might have been issues with the data collection tools, the issues were the same for both datasets.

As for future work in this topic, we have established that the effect of credit inflation exists and that one study credit is not very efficient motivator for students to put more effort into their work. Therefore it would be interesting to study this effect further, for example from the viewpoint of counter-measurements, or the effect of the knowledge deficit between the different curricula approaches.

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