Examining Attendance, Performance and Interest in a CS Course in Relation to Students' Achievement Goal Orientation and Self-Evaluation

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Abstract – There has been a lot of research related to the prediction of students' interest in a course and course performance. The findings are especially important for those fields (and courses) with high failure and dropout rates, such as computer science. Although many research in computer science education involve various motivational and learning strategy frameworks (like achievement goal orientation and Motivated Strategies for Learning Questionnaire – MSLQ), very few involve interest, attendance and self-evaluation. In this study, the aim was to see whether students' achievement goal orientation and self-evaluation of their pre-faculty programming knowledge are related to course performance, attendance and interest in an introductory computer science course. Additionally, we wanted to see if attendance and interest relate to course performance. The findings suggest that only task-approach has a positive correlation with final test scores (but not with mid-term test scores), and that all AGO constructs except other-avoidance correlate positively with interest. Also, attendance has a positive correlation with mid-term test scores (but not with final test scores) while interest has a positive correlation with both mid-term and final test scores. Finally, we suspect that attendance and mid-term test findings may be somewhat influenced by course and faculty policies.

I. INTRODUCTION

Although programmers and software engineers are sought by the market and job offerings are tempting, both common sense and experience have shown that not everyone can be a good programmer. Failure and dropout rates for computer science (CS onward) courses have always been high, thus widening the gap between market needs and available workforce. Consequently, a lot of effort has been put into research in order to produce some means to predict course performance and interest (and even procrastination [7]) in the field of CS based on students' motivation, learning strategies, self-efficacy, gender and so on [6, 8, 12, 13, 14, 15].

One widely used framework (and corresponding tool) for measuring students motivation is the Motivated Strategies for Learning Questionnaire (MSLQ) [10], and another also commonly used is the achievement goal orientation theory and framework (AGO onward) [1, 2, 3, 4, 9, 13]. Although both have been thoroughly tried and tested (and have significant overlaps), the AGO framework has seen some updates in recent years [4, 13] and is used in this research.

Achievement goals are broad categories of learners' aims/targets/purposes in evaluative learning settings [1, 9]. The primary goal of a learner with mastery (task) goal orientation is learning and mastery of a task for its own sake. Such learners are intrinsically motivated and tend to judge themselves in a self-referenced manner, based on their past attainments or their perceived task self-efficacy. Their focus is on effort and improvement. On the other hand, learners with performance (ego) goal orientation consider their achievements relative to the performance of others, in terms of interpersonal and normative comparisons. These two goal orientations determine different consequences in achievement contexts.

In addition to motivation, students' interest in the course topic is also an important research variable [5, 15]. Both short-term interest and long-term interest may be of importance, because the former relates to the course being attended, and the latter affects election of future courses [5]. We, as teachers, also believe that class attendance and

self-evaluation (of previous experience and knowledge) can be important variables to take into consideration. Attendance is an indicator of student engagement while self-evaluation reflects students' perception on their previous CS experience and knowledge.

The research presented in this paper is focused on trying to establish if there are any relations between CS students AGO scores and self evaluation scores with attendance, performance and interest in CS. One part of the research contains confirmatory studies regarding related work, while the other explores new potential relations in CS settings.

II. RELATED WORK

Achievement goal orientation (AGO onward) theory [1, 9] distinguishes between mastery goals (focused on task mastery) and performance goals (focused on demonstration of competence/ability to others). This mastery-performance goal dichotomy was subsequently revised to include a distinction between performance-approach and performance-avoidance goals [2]. The former is about striving to demonstrate competence and outperform others, whereas the latter refers to the objective of not performing worse than others and being perceived as incompetent. Elliot and McGregor [3] have further distinguished mastery-approach goals (aiming to improve one's knowledge and skills) and mastery-avoidance goals (avoid failure in learning, competence decline, and the like). This 2×2 framework has been widely used in educational research.

The latest version of the AGO framework (the 3×2 model used in this research) proposed by Elliot, Murayama and R. Pekrun [4] consists of 3 goals and 2 valences for each goal (positive and negative) resulting in 6 constructs (goal orientations): task-approach, task-avoidance, self-approach, self-avoidance, other-approach and other-avoidance (See Table 1). The idea proposed by the authors was to separate the mastery goal from the 2×2 model into two different constructs and therefore standards for evaluation: task-based competence (focusing on the task itself) and self-based competence (focusing on one-self's previous performance). The performance goal was renamed into "others" goal and still refers to demonstration of competence/ability when compared with others.

TABLE I. THE 3×2 AGO FRAMEWORK GOAL CONSTRUCTS [4]

Valence	**Goal**		
	Task	***Self***	***Others***
Positive valence	Task-approach *(focused on the attainment of task-based competence, e.g. "Do the task correctly")*	Self-approach *(focused on the attainment of self-based competence, e.g. "Do better than [I did] before")*	Other-approach *(focused on the attainment of other-based competence, e.g. "Do better than others")*
Negative valence	Task-avoidance *(focused on the avoidance of task-based incompetence, e.g. "Avoid doing the task incorrectly")*	Self-avoidance *(focused on the avoidance of self-based incompetence, e.g. "Avoid doing worse than [I did]before")*	Other-avoidance *(focused on the avoidance of other-based incompetence, e.g. "Avoid doing worse than others")*

There is another recent version of the AGO model proposed by Shell and Soh [13] which includes three goals (learning, task and performance) and two valences (approach and avoidance) and is very similar to the 3×2 model [4]. However, the 3×2 model was used in this research instead, only due to the many studies confirming it's validity in various settings.

AGO research in psychology education has proven that task-approach is a positive predictor of intrinsic motivation, learning efficacy and absorption in class, while the other-approach component positively correlates to course performance [4]. The same study has shown that other-avoidance correlates negatively with course performance and that self-approach and self-avoidance are affecting only energy in class, while task-avoidance does not relate to any specific variables [4]. In another study which involved the 2×2 AGO model [3], it was shown that mastery-approach positively affects interest in psychology, while performance-approach only has an effect on the final grade [5]. It was also proven that interest itself has a positive effect on the final grade [5]. Mastery-approach orientation, in general, is often associated with positive academic outcomes, whereas performance-avoidance approach was found to be correlated with negative academic outcomes [11]. However, it is important to note that course performance in all three studies was measured by tests with multiple-choice/open-ended questions where memorization of facts is the key to performing well [4, 5, 11].

In CS, however, exams may take the form of multiple-choice tests, but it is more often that students have to solve some programming task by creating a programming solution [15]. This involves more than memorization of facts – it requires combining various programming constructs while adhering to programming language rules and task requirements. It seems less surprising that motivation research in introductory

CS courses suggests that intrinsic motivation (MSLQ construct similar to AGO mastery was measured) correlates positively to total exam scores [8], instead of extrinsic motivation (similar to AGO performance). In a study employing the AGO framework [15] it was found that mastery-approach positively correlates with interest and final exam grade, while performance-approach negatively correlates with interest and has no relations with exam performance (contrary to [4, 5, 11]). The same study has shown that prior programming experience is not correlated with neither mastery nor performance but can predict interest in CS.

In another group of studies employing the alternative AGO framework by Shell and Soh [13], it as found that task-approach positively correlates with (course) achievement, knowledge retention, self-regulation, knowledge building and engagement [12] and that task-avoidance negatively correlates with self-regulation. It was also found that initial course motivation (AGO scores) changes during the semester [6], mostly that learning-approach, task-approach and performance-approach drop from initially high values and that learning-avoidance increases. It is therefore not surprising that initial motivation was found to be a weak predictor of course performance [14] and that the teachers should aim to: get CS students to set positive learning goals and help them make positive learning experiences [6], as well as maintain positive goals high throughout the semester [14].

III. GOALS AND RESEARCH QUESTIONS

The primary goal of this research was to explore students' motivation (as defined in the 3×2 AGO model [4]), self-evaluation (on pre-faculty knowledge) and course outcomes in an introductory CS course, as well as possible relations between:

- AGO and course attendance, interest, and performance.
- Self-evaluation and course attendance, interest, and performance.

The secondary goal was to explore our presumptions on whether attendance and interest are related to course performance.

IV. METHODOLOGY

A. Educational and research setting

The study was carried out in the 2019/20 academic year and involved 2nd year information systems students enrolled in an introductory course on object oriented programming. The course lasted 13 weeks and involved 1.5 hours of lectures and 1.5 hours of computer labs per week during which students had been learning Java and using the Eclipse development environment. The course was preceded only by one-semester programming course in C language from the first year.

The assessment involved two tests (mid-semester test – 35 points and final test – 65 points) where students were given programming tasks to complete in the computer labs in limited time. The tasks in each test involved creating simple Java programs based on the provided requirements, but also correcting non-syntax errors in the code that was provided. These two tests enabled practical measurement of performance (acquired programming knowledge and skill) and the scoring was such that deep understanding of the material was needed in order to get high scores (similar to [15]).

Out of the 682 enrolled students, 215 decided to take part in the study (130 female, 85 male) with GPA ranging from 6.33 to 10.0 (M = 7.97, SD = 0.767). Average students' age was 20.62 years.

B. Data collection and analysis

The students' AGO scores, self-evaluation and interest scores were obtained through an online questionnaire administered during class in the fifth week of the course (one week before the mid-semester test), so students could get familiar with the course and adjust their initial motivation (in accordance with [6, 14]). The questionnaire consisted of four sections: general data, AGO, interest and self-evaluation. Those who did not attend the classes when the questionnaire was administered, but wanted to take part in the research, were asked to fill it out in the following week.

Participating in the study was voluntary, with no effect on students' course grades. The invited students were informed about the purpose and conditions for participation in the research. The questionnaire was not anonymous and students gave their signed consent for using this data together with GPA, course test scores and attendance data for research purposes provided that their identities were kept hidden.

For the AGO part of the questionnaire, items from the 3×2 AGO model were translated to Serbian and used [4]. This questionnaire has 18 statements (items) in total – three per factor.

Students' level of agreement with each statement was elicited on a scale from 1 to 7 (1 being "Totally disagree," 3 - "Not sure," and 7 - "Totally agree"). Individual factor scores were calculated as average values from the corresponding three item scores. The Cronbach alpha test (Table 2, Cr. α column) suggests good internal consistency among corresponding items except for a somewhat lower value for the task-avoidance items (α = 0.62). This may be due to the questionnaire being translated.

Students' interest in the course was measured by using a standard 10 item questionnaire with each statement being elicited on a scale from 1 to 7 (1 being "Totally disagree," 3 - "Not sure," and 7 - "Totally agree") [5, 15]. Final interest scores were calculated as average values from the corresponding 10 item scores, with one item score being inverted as predicted by the questionnaire.

Self-evaluation consisted of a qualitative description on pre-faculty programming experiences as well as a self-evaluation score on a scale from 1 to 5 (5 being the highest score).

Lab attendance was formally tracked, and students were aware of this. There were three extra points for regular attendance (attending at least 10 out of 13 labs) but no consequences for not attending. Both attendance and test scores were recorded via private-based spreadsheets and paired up with other data for further analysis.

V. RESULTS

A. Descriptive statistics

The descriptive statistics (Table 2) suggest that students' motivation was, in general, very high concerning the task-approach, task-avoidance, self approach and self-avoidance AGO constructs, and that other-approach and other-avoidance were more moderate. Students' interest was also very high.

TABLE II. AGO AND INTEREST SCORES

Factor	Min	1stQ	Med.	3rdQ	Max	Cr. α
Task-approach	3.667	6.000	6.667	7.000	7.000	0.82
Task-avoidance	3.333	5.500	6.333	7.000	7.000	0.61
Self-approach	1.000	5.333	6.333	7.000	7.000	0.80
Self-avoidance	1.333	5.000	6.000	7.000	7.000	0.75
Other-approach	1.000	2.333	4.000	5.000	7.000	0.91
Other-avoidance	1.000	2.833	4.333	5.667	7.000	0.90
Interest	2.300	5.800	6.300	6.800	7.00	0.93

In the qualitative ("descriptive") part of the self- evaluation on their previous programming experience, 46.52% of students stated that they mostly learned programming in high school, 6.97% said that they mostly learned programming themselves, while 46.51% stated that they did not learn programming before the faculty. In the self-evaluation score, most students evaluated their pre-faculty knowledge and experience in programming as low or very low (Figure 1).

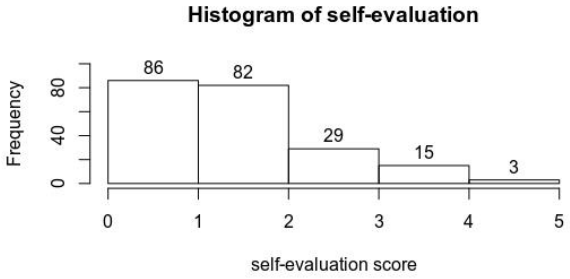

Figure 1.Self-evaluation on pre-faculty programming experience

Student attendance distribution was also not normal, and average attendance was high, peaking at 10 attended classes (Figure 2).

Mid-term test scores (Figure 3) were also not normally distributed (Shapiro-Wilk, $p < 0.01$), but did seem to have a flattened, bell-shaped distribution. Twenty students had not attended the mid-term test.

Final test scores (Figure 4) were not normally distributed (Shapiro-Wilk, $p < 0.01$), but did seem to have a left-skewed, bell-shaped distribution. Twenty seven students had not attended the final test.

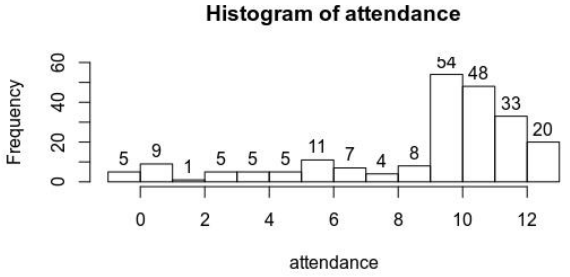

Figure 2.Student attendance histogram

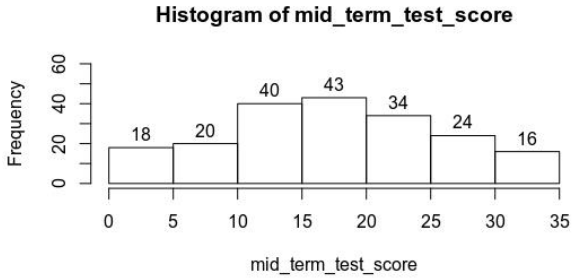

Figure 3.Mid-term test score distribution

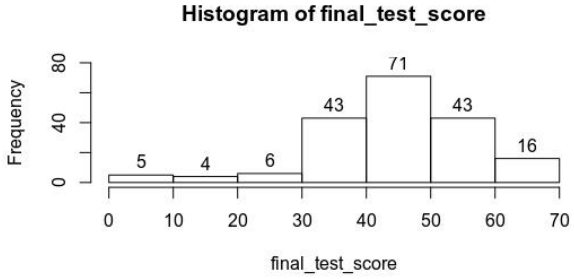

Figure 4.Final test score distribution

B. AGO and self-evaluation – relations with attendance, performance and interest

The data suggest that task-approach has a weak positive correlation (Spearman) with interest and the final test score (but not the mid-term test score), and that task-avoidance, self-approach, self-avoidance and other-approach also have a weak positive correlation with interest (Table 3). The data also reveal that attendance is not correlated with any of the AGO constructs. Finally, tests have shown that self-evaluation scores are in weak positive correlation with interest and performance (mid-term and final test scores), and that no statistically significant correlations with attendance could be found.

TABLE III. AGO AND SELF-EVALUATION CORRELATIONS

	Attendance	**Interest**	**Mid-term test score**	**Final test score**
Task-approach	$r_s = 0.0472$ $p = 0.49$	$r_s = 0.2799$ $p < 0.01$	$r_s = 0.0122$ $p = 0.86$	$r_s = 0.1979$ $p < 0.01$
Task-avoidance	$r_s = 0.0332$ $p = 0.63$	$r_s = 0.1529$ $p < 0.05$	$r_s = 0.0124$ $p = 0.86$	$r_s = 0.0884$ $p = 0.23$
Self-approach	$r_s = - 0.0237$ $p = 0.73$	$r_s = 0.2005$ $p < 0.01$	$r_s = -0.0694$ $p = 0.33$	$r_s = 0.0667$ $p = 0.36$
Self-avoidance	$r_s = -0.0476$ $p = 0.49$	$r_s = 0.1997$ $p < 0.01$	$r_s = -0.0379$ $p = 0.59$	$r_s = 0.1273$ $p = 0.08$
Other-approach	$r_s = -0.0629$ $p = 0.36$	$r_s = 0.2190$ $p < 0.01$	$r_s = 0.0396$ $p = 0.58$	$r_s = 0.0816$ $p = 0.27$
Other-avoidance	$r_s = -0.0211$ $p = 0.76$	$r_s = 0.1184$ $p = 0.08$	$r_s = 0.0066$ $p = 0.93$	$R_s = 0.0363$ $p = 0.62$
Self-evaluation	$r_s = 0.0551$ $p = 0.42$	$r_s = 0.2182$ $p < 0.01$	$r_s = 0.2213$ $p < 0.01$	$r_s = 0.1538$ $p < 0.05$

C. Attendance and interest – relations with performance

The data suggest that attendance has a weak positive correlation with the mid-term test score only, and that interest has a weak positive correlation both with the mid-term test and the final test score (Table 4).

TABLE IV. ATTENDANCE AND INTEREST CORRELATIONS WITH PERFORMANCE

	Mid-term test score	**Final test score**
Attendance	$r_s = 0.3112$ $p < 0.001$	$r_s = 0.0974$ $p = 0.18$
Interest	$r_s = 0.2441$ $p < 0.01$	$r_s = 0.2148$ $p < 0.01$

VI. DISCUSSION

A. Descriptive statistics

The data suggests that students' motivation regarding all task and self goals was very high, both in positive and in negative valences (approach and avoidance). We, as teachers, interpret this as students being motivated to do their tasks well, improve their knowledge and do better than they did before. However, at the same time, students avoided not doing well both in task completion and with regards to their previous performance. This is somewhat in line with previous research where initial course motivations with positive valences were very high [6] – although in our research motivation was measured five weeks into the semester (one week before the mid-term test). On the other hand, the other-goal scores were moderate and, to our surprise, the other-approach goal scores (performing better than others) were lower than the other-avoidance goal scores (avoid under-performing when compared to others). This means that students wanted to avoid under-performing more than they wanted to outperform their colleagues.

The qualitative self-evaluation statistics convey that nearly half of the surveyed students did not learn programming before the faculty. It is our interpretation that many of those that had learned programming did not feel that they have learned well. The self-evaluation scores reflect this – 168 out of the 215 surveyed students evaluated their pre-faculty programming knowledge as low or very low.

The course policy to give additional points for regular attendance (attending 10 classes or more) seems to have motivated students to attend classes regularly. Attendance among the surveyed students was high, peaking at 10 attended classes.

Mid-term test scores have a very symmetrical distribution meaning that both low, average and high scores are present, with most students doing averagely. This is somewhat expected as students have only one chance to take this test (per academic year, as stated in the faculty policy) and the test results affect a large proportion of the total course score (35 out of 100 points). Students have to take this test even if they haven't prepared for it well.

Final test scores have a left skewed distribution, meaning that above-average scores prevail. This is also expected as this test can be taken several times during the academic year, and students can take the test again if they are not satisfied with their score.

B. AGO and self-evaluation – relations with attendance, performance and interest

The task-approach goal has a weak but positive correlation with the final test score, which is in line with previous research in CS education [12, 13, 15], but is contrary to the psychology education research findings, where only performance-approach positively affects exam performance [4, 5, 11]. Again, this could be due to the type of assessment being taken (as noted in [15]): multiple-choice/open-ended questions where memorization is key to success (psychology), versus programming tasks where deep knowledge is necessary. What is still unclear is why task-approach (or any other AGO construct) is not correlated with attendance or the mid-term test score. It is our assumption that both the course policy (additional points for attending 10 classes or more) and the mid-term test policy (only one chance to take this test), have driven students to embrace the desired behavior and, perhaps, behave differently than they normally would.

The data also suggest that all AGO constructs except for other-avoidance have a weak positive correlation with interest. Some positive correlations were expected (task-approach and self-approach, similar to [15]), however, other-approach proved to have a positive correlation with interest, while a similar study resulted in a negative one being reported [15]. It is unclear why task-avoidance and self-avoidance have a positive correlation with interest. No studies, both in CS and psychology education, report similar findings.

The tests have shown that self-evaluation scores on pre-faculty programming experience and knowledge have weak positive correlations both with performance (mid-term and final test scores) and with interest. It seems that students who report higher levels of pre-faculty knowledge in CS are more interested in CS during faculty (similar to [15]), and achieve better performance in CS courses (which is not surprising). However, self evaluation scores are not related with attendance in any way.

C. Attendance and interest – relations with performance

The tests have shown that attendance has a weak and positive correlation only with the mid-term test score (and no correlation with the final test score). We, as teachers, interpret this finding as follows: regular lab attendance can help students achieve higher mid-term test scores as this test can be taken only once during the academic year (due to faculty policy). However, students can prepare for the final test in a more relaxed manner and catch-up with missed lessons later during the semester, and this is why regular lab attendance may not be so important.

The data also suggest what we presumed to be true: interest in CS is positively correlated with performance (both mid-term and final test). This is in line with similar findings both in psychology [5] and CS [15] education.

CONCLUSION

Introductory CS course students from our study were very motivated to do their tasks well, improve their knowledge and do better than they did before. At the same time, they were highly motivated to avoid doing worse than (they did) before, both generally and with regards to course tasks. They were moderately motivated to outperform their peers, but wanted to avoid under-performing their peers slightly more. Attendance was high, but it is unclear was it because of students' pure motivation or due to the course policy on additional points.

Only task-approach proved to have a weak but positive correlation with the final test score, and all AGO constructs except for other-avoidance had a weak positive correlation with interest. Self-evaluation scores were proved to have weak positive correlations with performance (mid-term and final test scores) and interest. Attendance had weak and positive correlation only with the mid-term test score, and we believe that this may be due to faculty policy on mid-term tests. Finally, as expected, interest in CS was positively correlated with performance (both mid-term and final test).

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