Changes in Student Goal Orientation across the Semester in Undergraduate Computer Science Courses

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Abstract—Students’ goal orientations impact their self-regulation, engagement, and achievement in post-secondary STEM courses. But, how students’ goal orientations change across a semester and the impacts of these changes have not been extensively studied. Study purposes were to investigate goal orientation change across the semester, associations of goal change with achievement and self-regulation, and associations of classroom climate with goal change. Participants were 175 students from college introductory computer science courses. MANOVA identified significant during semester decreases for all goal orientations except task-avoid (Wilks’ $\lambda = .724$, $F (6, 169.00) = 10.71$, $p < .001$, partial $\eta^2 = .276$). No differences in goal orientation change were found for gender, year in college, or course. Goal orientation change significantly predicted students’ course grades, retention of CS content, and strategic self-regulation. Classroom climate significantly predicted goal orientation change. Results indicate that students began the semester with positive goal orientations, but shifted in negative directions over the semester. In college STEM classes, the primary motivational issue may not be motivating students’ to initially set learning-and task-approach goals, but rather motivating them to maintain their initial positive goals. Perceptions of course affect and teacher directedness predicted students’ goal shifts, suggesting potential avenues for intervention by educators.

Keywords—motivation; self-regulation; goal change; STEM learning; goal orientation; affect; goal revision

I. INTRODUCTION

The need for more post-secondary students to major and graduate in science, technology, engineering, and math (STEM) fields is widely recognized as in the National Academies report “Rising above the gathering storm: Energizing and employing America for a brighter economic future” [1]. Likewise, substantial funding is provided for enhancing instruction in STEM fields to improve academic achievement and persistence [2]. However, a relatively low percentage of students major in STEM fields, and despite attracting students with generally better academic preparation and aptitude, students in STEM fields experience higher attrition than those in other post-secondary majors [2].

Student goals have been shown to play an important role in academic achievement and in student self-regulation and engagement across several domains [3, 4, 5]. Because of this strong impact of goals on student success, the goals students have for their STEM courses play a significant role in their course achievement and ultimately in their retention and successful degree completion. Although there has been extensive research on goals and goal orientation, goal change in the academic setting has been less examined. This is especially true for post-secondary level STEM courses. We know that students in introductory computer science courses vary in the goals they adopt [6], but we know little about the dynamics of their goal adoption over the course of the semester. Goal change is important because efforts to motivate students to initially set goals in their courses that lead to better self-regulation, engagement, and ultimately better achievement will pay off only if students retain these productive goals. If students shift their course goals either volitionally or in response to aspects of the classroom environment, then instructors will need to pay more attention to ongoing maintenance of previously established goals to avoid negative student outcomes.

Our intent in this study was to help answer questions about the prevalence and impacts of goal change by investigating goal change across the semester and its impact on course achievement and strategic self-regulation in introductory computer science (CS1) courses. The CS1 courses examined were from a suite of CS1 courses each tailored to a different target group (CS majors, engineering majors, combined CS/physical sciences majors, combined business/CS honors program, and humanities majors). All were required within the students’ respective fields of study. For non-CS students, the courses reflect the typical non-major courses that are foundational to later study within the major. For CS students, the course is their introduction to formal CS study. The courses contain a broad mix of students from diverse STEM and non-STEM fields with differing levels of CS background. As such, the students in these courses are typical of the broader STEM student population.

II. THEORETICAL FRAMEWORK

A. Goal Orientation

Goal theory is a mature field that has been extensively studied. It is well established that students set goals for their classes and set achievement goals for their specific tests and assignments [5, 7]. What has been less studied is the stability
of goal orientations over time and from the start to the end of a
course. As a result, much is known about how students’ goals
at a specific point-in-time impact their achievement and self-
regulation, but little is known about the dynamics of goal change
that might be occurring over the course of semester. This
is especially true for post-secondary courses as the
research that has been done on goal orientation stability has
focused primarily on elementary and middle school ages [8, 9,
10]. Our purpose in this study was to determine how students’
goal orientations for their course shifted during the semester
and the impact of these goal shifts on student achievement and
strategic self-regulation. We also examined aspects of the
classroom climate that may influence student goal shifting.

Goal orientation theories focus on the types of goals
students set. Goals and goal orientation have been linked to
academic achievement in numerous studies [3, 4, 5, 6]. As
noted by Elliot et al. [7], there are achievement goals students
set for specific tasks. These include the goals students have for
completing a course assignment, taking a test, or doing lab
work and are specific to the performance of a single task at a
specific time. There also are more general goals that students
set for a course as a whole [5, 6, 7, 11]. These goals concern
what students hope to achieve by taking and completing the
class. In this study, we used a framework proposed by Shell
et al. [11] and Shell and Soh [6] that examines goal orientations
students have for their class in three dimensions (learning,
performance, and task) with each dimension having an
approach and avoid component.

Learning-approach goals are directed at learning new
knowledge or gaining competence consistent with most past
formulations of learning or mastery goals [5, 12]. Learning-
approach goals for a class focus on deep understanding and
personal growth and development in the subject area.
Learning-avoid goals are deliberate goals to avoid learning
course material. In keeping with the saying “you can lead a
horse to water, but you can’t make it drink,” a student might
complete all assignments and do enough to get a test score or
grade, but not put forth the additional effort to really learn the
material.

Performance-approach goals reflect a desire to obtain
favorable judgments of one’s abilities by others or perform
better than others in the class. Students pursuing performance-
approach goals focus on competition and formal assessments
of accomplishment and achievement such as grades. Perfor-
ance-avoid goals reflect the desire to avoid negative
judgments of one’s ability or do worse relative to others. Stu-
dents pursuing performance-avoid goals focus on the conse-
quences of failure and poor performance. These are consistent
with past formulations of performance goals [5].

Task-approach goals reflect wanting to perform well on
course assignments and tests [6, 11, 13]. They differ from
performance goals because they are about doing well without
reference to normative performance or evaluations of
competence. They also differ from learning goals in that
students can have a goal to “do my work to the best of my
ability” without any expectation that they will learn anything.
Task- or work-avoid goals reflect a desire to get through the
class with as little time and effort as possible [9, 14, 15, 16].

B. Strategic Self-Regulation

Students’ strategic self-regulation in classes has been ex-
tensively studied and depends on three components. First, stra-
ategic self-regulation depends on students being metacognitively
active: engaging in active planning, monitoring, and
evaluation of their learning and applying general learning
strategies to accomplish their goals [17, 18]. Pressley et al.
[19] refer to such students as “good strategy users.”

Second, students’ strategic self-regulation involves the
knowledge building approach to learning proposed by
Scardamalia, Bereiter, and their colleagues [20, 21] as well as
constructivist approaches to classroom learning [22]. Central
to the knowledge building approach is the idea that meaningful
learning involves the production of knowledge rather than the
reproduction of knowledge. This knowledge building is
accomplished by an in-depth study of a topic that goes beyond
simple factual or recall learning. Learning is tied to personally
meaningful goals and includes examination and connection of
new knowledge to existing knowledge and coursework in other
classes.

Third, strategic self-regulation may involve dysfunctional
self-regulatory strategies [12, 16, 23, 24]. Lack of regulation
[6, 11, 23] describes students who are confused, have difficulty
studying effectively and self-regulating, and also need support
from others. Lack of regulation has been shown to be
negatively associated with grades [6, 23] and is a key
component of learned helplessness in classes [6, 15].

Prior research has found that all of these components of
strategic self-regulation are affected by goal orientation [4, 15,
25, 26]. Students’ general metacognitive self-regulation and
knowledge building are associated with higher learning-
approach goals and task-approach goals [4, 15]. General
metacognitive self-regulation has been associated with
performance-approach goals [4, 26]. Avoid goals have been
associated with lower metacognitive self-regulation and
knowledge building [27, 28]. Lack of regulation has been less
well studied, but has been associated with higher performance
and task avoid goals [29].

Research is lacking on the impacts that goal change during
a course may have on these aspects of strategic self-regulation.
Although it might be anticipated that impacts of goal change
would mirror those found for single point-in-time associations,
this has not been examined.

C. Classroom Perceptions and Goal Orientation

The impact of goal structure and students’ perceptions of a
class as more mastery or performance structured has been ex-
tensively studied. It has been argued that the characteristics of
the classroom, such as the way in which the teacher delivers
material and evaluates students, impact the types of goals that
students adopt [14]. Also, students learning in a group setting
have been shown to adopt learning or mastery goals due to that
context’s mastery oriented nature [14, 30]. Researchers have
more recently investigated levels of goal orientation within
collaborative/cooperative settings (individual, individual within
a group, group) [30], but less studied has been the impact of
factors such as collaborative/cooperative learning and teacher directedness on students’ course goals stability.

Affect/emotion involves students’ general feelings and reactions to the class [31, 32]. Positive emotions have been shown to increase students’ engagement in academic work and support more adaptive self-regulation [6, 15, 32]. Negative emotions have been found to decrease motivation and lead to maladaptive self-regulation [6, 15]. Affect/emotion also has a relationship with goal setting and goal pursuit. Studies have shown that positive affect/emotional experiences in classrooms enhance students’ setting of learning- and task-approach goals [33]. Students can be impacted by the emotional instability they are faced with in classroom settings due to issues such as the difficulty of the course material [33]. Test anxiety in particular has been shown to be related to performance-avoidance goals [15]. However, the impact of affect/emotion on goal stability and change is less clear.

III. THE PRESENT STUDY

The goal of this study was to investigate how students’ goal orientation changed across the semester. Our secondary research objectives were to examine how changes in goal orientation were related to course achievement, learning, and strategic self-regulation and how goal change was associated with students’ perceptions of the classroom environment and their emotional/affective reactions to the course. This study was part of a larger NSF-funded effort to improve learning of computational and creative thinking [34, 35].

At FIE in 2013, we reported on findings that conformed to most of the prior goal orientation research [36]. We found that in post-secondary introductory computer science (CS1) courses, learning- and task-approach goal orientations were positively associated with higher grades and learning and with higher strategic self-regulation and knowledge building and lower lack of regulation. We also found that higher learning- and performance-avoid goal orientations were associated with lower grades and learning, higher learning- and task-avoid goal orientations were associated with lower strategic self-regulation and knowledge building and higher lack of regulation. Finally, we found that higher performance-approach goal orientation was associated with higher strategic self-regulation and knowledge building. Although these findings support the importance of students’ goal orientation to their achievement and strategic self-regulation in introductory computer science courses, the prior study examined only students’ goal orientations at the end of the course. It did not consider the impact of goal orientation change across the semester from beginning to end.

IV. METHODS

A. Participants and Procedures

Participants were 175 students who consented to participation (151 men; 24 women; 78 freshman, 49 sophomores, 32 juniors, 13 seniors, 3 other/unknown) from five courses in a suite of required introductory computer science course (CS1) at a large Midwestern state university. Courses included one for CS majors, one for a combined business/computer science honors program major, one for engineers with content tailored for engineering, one for a mix of CS, engineering, and general science majors, and one for humanities and journalism majors. The courses all are required within the students’ major field of study (e.g., engineering, physics, computer science, etc.). Core content was the same for all courses, but courses were tailored for different majors with different programming languages and lab exercises.

B. Goal Orientation Measures

Students’ course goal orientation was measured with an instrument used by Shell et al. [34] adapted from that used by Shell and Soh [6]. Learning-approach goal orientation (2 items) assesses goals for developing long-term, deep understanding of information and skills learned in the course (e.g., “Learning new knowledge or skills during the class just for the sake of learning them”). Learning-avoid goal orientation (2 items) assesses deliberate avoidance of long-term learning or retention of course information (“Getting a grade whether you remember anything beyond that or not”). Performance-approach goal orientation (2 items) assesses normative performance relative to other students and favorable assessments of ability by the instructor for ego protection (e.g., “Doing better than the other students”). Performance-avoid goal orientation (2 items) assesses avoiding negative performance evaluations and unfavorable assessments of ability by others (e.g., “Keeping others from thinking I am dumb”). Task-approach goal orientation (2 items) assesses efforts to achieve highly and do well on class assignments and activities without reference to normative comparisons (e.g., “Doing my best on course assignments and tests”). Task-or work-avoid goal orientation (2 items) assess deliberate intention to put forth minimal effort in the course (e.g., “Getting through this course with the least amount of time and effort”).

Participants rated goals on a 5-point Likert scale from 1 (very unimportant) to 5 (very important). Scores were computed as the mean score of the items in each scale. Reliability cannot be statistically estimated accurately for 2-item scales, however, Cronbach alpha estimates for the parent scales [6] were .89, .88, .78, .87, .91, and .82 for the learning approach, learning avoid, performance approach, performance avoid, task approach, and task/work avoid scales respectively.

C. Strategic Self-Regulation Measures

Strategic self-regulation was assessed with three scales from the Student Perceptions of Classroom Knowledge Building instrument (SPOCK) [6, 15, 23]. Self-regulated strategy use (5 items) assesses the extent of participant planning, goal setting, monitoring, and evaluation of studying and learning (e.g., “In this class, I tried to monitor my progress when I studied”). Knowledge building (5 items) assesses the extent of student exploration and interconnection of knowledge from the class (e.g., “As I studied the topics in this class, I tried to think about how they related to the topics I have studied in other classes”). Lack of regulation (4 items) assesses participants’ lack of understanding of how to study and need for as-
sistance and guidance in studying (e.g., “In this class, when I got stuck or confused about my work, I needed someone else to figure out what I needed to do”).

All questions were answered on a five-point Likert scale from 1 (almost never) to 5 (almost always). Scores were computed as the mean score of the scale items. Cronbach alpha reliability estimates for the self-regulated strategy use, knowledge building, and lack of initiative scales were respectively .82, .86, and .69.

D. Course Perception Measures

Students’ course affect was measured by a modified version [6, 15] of the Positive and Negative Affect Schedule (PANAS) [37]. Two substitutions were made to the list of emotions from the original scale to better reflect academic classroom emotions. Capable was substituted for strong and frustrated was substituted for Jittery. Participants rated the frequency with which they experienced ten positive (e.g., excited, inspired, determined) and ten negative (e.g., nervous, distressed, upset) emotions on a 5-point scale from 1 (a few times or none) to 5 (most of the time, 80%-100% of the time). Scores were computed as the mean of the items in each scale. Cronbach alpha reliability estimates for the positive and negative scales were respectively .92 and .90.

Students’ classroom perceptions were assessed with two scales from SPOCK [23]. Collaborative learning (4 items) assesses students’ perceptions of collaboration with fellow students (e.g., “In this class, my classmates and I actively shared ideas”). Teacher directedness (3 items) assesses students’ perceptions of the class as being instructor oriented (e.g., “In this class, the instructor told us what the important information was”). Questions were answered on a five-point Likert scale from 1 (almost never) to 5 (almost always). Scores were computed as the mean score of the scale items. Cronbach alpha reliability estimates for the collaborative learning and teacher directedness scales were respectively .86 and .69.

E. Course Achievement and Computational Thinking Knowledge Test

Students’ course grades were obtained from University records. Students’ retention of computational thinking knowledge and skills from the course was measured with a computational thinking knowledge test developed by Computer Science and Computer Engineering faculty [6, 36]. The test contained thirteen conceptual and problem-solving questions for the core computational thinking content common to all the CS1 classes. The Cronbach alpha reliability estimate was .76.

F. Procedures

All measures and the computational thinking knowledge test were administered using Survey Monkey® during course lab periods. The pre-test for the goal orientation measures was done during the first week of class and the post-test for all measures and the knowledge test was done during the last week of classes as part of broader evaluation data collection.

V. RESULTS

A. Change in Student Goal Orientation

Multivariate analysis of variance (MANOVA) was run to assess changes in student goal orientation from the beginning to the end of the course. The overall MANOVA was significant (Wilks’ $\lambda = .724$, $F (6, 169.00) = 10.71$, $p < .001$, $\eta^2 = .276$) with student ratings changing for all goal orientations except task-avoid.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-Test M</th>
<th>Pre-Test SD</th>
<th>Post-Test M</th>
<th>Post-Test SD</th>
<th>F</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Approach</td>
<td>3.31 .90</td>
<td>3.01 .94</td>
<td>10.77 $^b$</td>
<td>.061</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance Avoid</td>
<td>2.94 1.02</td>
<td>2.70 1.03</td>
<td>6.50 $^a$</td>
<td>.038</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning Approach</td>
<td>4.35 .64</td>
<td>3.99 .90</td>
<td>25.75 $^b$</td>
<td>.135</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning Avoid</td>
<td>2.34 .97</td>
<td>2.61 1.03</td>
<td>8.21 $^b$</td>
<td>.048</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task Approach</td>
<td>4.64 .56</td>
<td>4.25 .93</td>
<td>24.86 $^b$</td>
<td>.131</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task Avoid</td>
<td>2.57 .96</td>
<td>2.58 .99</td>
<td>0.05</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We also conducted a series of MANOVA tests to assess differences in change in goal orientation by gender (Wilks’ $\lambda = .954$, $F (6, 168.00) = 1.34$, $p = .243$, $\eta^2 = .046$), year in college (Wilks’ $\lambda = .892$, $F (18.00, 485.00) = 1.058$, $p = .393$, $\eta^2 = .037$) and the section of the course students were enrolled in (Wilks’ $\lambda = .854$, $F (18.00, 453.034) = 1.449$, $p = .104$, $\eta^2 = .051$). Results of all these tests were not significant.

B. Association of Achievement and Strategic Self-Regulation with Goal Orientation Change

To examine how changes in students’ goal orientations for the class were associated with their achievement and strategic self-regulation, multiple regression analysis was conducted. Difference scores were computed by subtracting pre-scores from post-scores so that increases in goal orientation during the semester produced positive difference scores. Results are shown in Table II. Students’ course grades and retention of content were significantly associated with increase in task-approach goal orientation. Students who increased in goals to do their best and perform well achieved at higher levels. Also, student grades were significantly associated with decreases in learning-avoid goal orientation. Students who decreased in goals to avoid learning the course content had higher grades.

Students’ general strategic self-regulation and knowledge building were both associated with increase in learning-approach goal orientation. Students who increased their goals to deeply learn the course content appear to have increased their use of strategic self-regulatory strategies that would help accomplish these goals. Also, general strategic self-regulation and knowledge building were both associated with decrease in task-avoid goal orientation. Students who decreased in goals to put forth minimal effort appear to have increased their active strategic self-regulation. Lack of regulation was associated with increase in learning-avoid goal orientation. Students who
increased in goals to avoid learning the course content appear to have increased difficulty in effective strategic self-regulation.

C. Association of with Goal Orientation Change with Classroom Perceptions and Affect

To examine classroom factors that might have impacted goal orientation change, goal orientation difference scores were regressed on student perceptions of the classroom environment and affect (Table III). Overall multiple regression was not significant for performance-approach and performance-avoid goal orientation change. This suggests that performance goal orientation change is not strongly impacted by aspects of the classroom climate, although negative affect was individually associated with decrease in performance-approach goal orientation.

Increase in learning-approach goal orientation was associated with higher positive affect and lower negative affect, suggesting that maintenance of learning-approach goals may be highly sensitive to students’ emotional engagement and reaction to the course [31, 32]. Increase in learning-avoid goal orientation was associated with lower positive affect and higher perception of teacher directedness, suggesting that if students are having less positive experience they may shift toward goals to avoid learning course content. Also, overly controlling teacher directed classrooms may lead students toward learning avoidance.

VI. DISCUSSIONS AND CONCLUSIONS

The achievement goals and goal orientation literature has primarily focused on the question of how to encourage students to set more positive mastery/learning- or task-approach goals [3, 5, 38]. Our results indicate that college students taking introductory computer science (CS1) courses begin the class with generally high learning- and task-approach goal orientation and lower performance-, learning-, and task-avoid goal orientations. This suggests high levels of motivation and generally positive goals for learning the course content among entering students. But, we found that these initial positive goal orientations change in more negative directions over the semester. Both performance-approach and performance-avoid goal orientations dropped, which would generally be considered good for student motivation and learning [5, 11]. However, both learning- and task-approach goal orientations dropped and, particularly problematic, learning-avoid goals increased. These shifts indicate that students’ positive goals to learn, achieve, and put forth best efforts decrease as the semester progresses and are increasingly replaced by goals to avoid learning the course content. This suggests that in these computer science classes the issue may not be how to motivate students to set learning and task goals, but rather how to motivate them to maintain their initially high learning- and task-approach goals.

Another important aspect of this research was to investigate how changes or maintenance of goal orientation related to achievement and self-regulation. Higher course grades and knowledge test scores were associated with increase in task-approach goal orientation. Students who increased in their goals to do their best achieved at higher levels and learned more. Conversely, increasing in learning-avoid goal orientation was associated with lower course grades. Not surprisingly, students who increase in deliberate avoidance of learning the course material perform less well.

Higher student strategic self-regulation and knowledge building were associated with increase in learning-approach goal orientation. Students who increase in setting goals for meaningful personal learning of the course content appear to increase in the self-regulatory behaviors and strategies needed to accomplish this goal. Conversely, increasing in task-avoid goal orientation was associated with decreases in self-regulatory behaviors and strategies. This is logical, as students...
who increase in goals to do as little as possible and put forth minimal effort are unlikely to engage in extensive self-regulation or deep learning strategies. Those students that increased in positive goal orientations (e.g., task-approach, learning-approach) or decreased in negative goal orientations (e.g., task-avoid, learning-avoid) increased in self-regulation strategies and had higher achievement.

These associations of goal orientation change with achievement and strategic self-regulation mirror those we found for single point-in-time end of semester associations between goal orientation and grades and student self-regulation [36]. The findings suggest that within a class both the students’ current goals and their history of goal change are important. Decreases in productive goals like learning-approach and task-approach may undermine the motivational benefits students realize from setting and pursuing these. Increases in dysfunctional learning-avoid or task-avoid goals may lead to diminished motivation and reduced strategic self-regulation and problems with effectively studying and learning course material.

Results show that perceptions of course affect and teacher directedness have potentially important impacts on how student’s goal orientations shift across the semester. Consistent with much recent research on the advantages of maintaining a positive affective climate in classrooms [31, 32, 33], positive affective/emotional reaction had the strongest association with increasing learning- and task-approach goal orientations. Positive affect also was associated with reductions in learning-avoid goal orientation.

Results for perceptions of collaboration and teacher directness showed inconsistent possible impacts. Although collaboration has been associated with other positive aspects of student motivation [20, 21, 22, 30], perception of collaboration with other students was not associated with students’ goal orientation change. Perceptions of teacher directedness had somewhat contrary effects. Higher teacher directedness was associated with shifts toward higher task-approach goals, but at the same time was associated with shifts toward higher learning-avoid goals. These findings suggest that teacher direction and control may foster a student focus on the more external aspects of achievement and evaluations such as grades rather than on personally meaningful deep learning.

Findings suggest that goal orientations are sensitive to aspects of the classroom climate (especially course affect) and are therefore potentially malleable through specific interventions and teaching approaches. Future study on these impacts and on possible interventions is needed to increase our knowledge of how to help students both set and maintain goals that positively motivate achievement and strategic self-regulation.

This research adds important information to the goals literature. Classroom climate and students’ affective reactions are associated with how they revise their goals over the course of a semester. These shifts in goals appear to be linked to changes in self-regulation strategies and knowledge building and in turn, linked to course performance and knowledge acquisition. Further research is needed to investigate these findings and extend this examination to other STEM and non-STEM courses. That goals did change over the course of the semester is noteworthy because there is reason to investigate interventions and practices that might be instituted to mitigate negative change and increase goal adoption in ways more consistent with higher levels of academic achievement.

Students appear to be entering this CS1 course with highly positive and optimistic goals for their learning and engagement. Study findings suggest that maintaining these positive goals may be problematic for many students. However, there is one encouraging aspect. We observe that, despite aggregate decreases in learning- and task-approach goal orientations, about half of all students either maintained or even increased these. This suggests that there is potential for helping students maintain and even enhance their productive course goals.

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