Shifting Goals in Introductory and Advanced Computer Science Courses: The Effects of Gender and Major

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***Abstract*—This Research Full Paper examines changes in computer science (CS) students' achievement goals. The types of goals students set impact other things such as self-regulation strategies and learning, and evidence indicates that the kinds of goals students set and pursue within a class shift during the course of that class. A 3 x 2 goal orientation framework was used to explore shifts in undergraduate CS students' goals. This study contributes to the research literature on changes in CS students' goals and extends previous work by using multiple analytic techniques to examine students in upper-level courses as well as factors that might be associated with changes in goals. Study 1 examined students in 100-level courses and Study 2 examined students in more advanced courses. The primary research questions addressed in both studies were (1) how do the goals of undergraduate CS students change during the semester? and (2) are changes in goals different for men and women or for CS majors and non-majors? Students self-reported the perceived importance of the various types of achievement goals at the beginning, middle, and end of the semester. Study 1 results indicated that on average, 100-level students' ratings of the importance of all types of goals except task/work avoidance goals changed across the semester. Individual-level analyses revealed that comparable proportions of students demonstrated increases and decreases in this type of goal, resulting in the lack of change at the group level. Some of the goal types differed according to major status, and only task approach goals showed any gender effects. Study 2 found that on average students in upper-level courses similarly demonstrated significant decreases in all approach goals and performance avoidance goals during the semester. Task/work avoidance goals again did not change significantly overall, but again comparable proportions of students demonstrated increases and decreases. Task/work avoidance goals also differed according to major status. For task approach goals, all interactions and main effects except the main effect of gender were significant. Non-major women had the lowest task approach goals and the most change, but CS-major women had the highest task approach goals and the least change. In both studies, performance avoidance goals had the greatest proportion of students demonstrating reliable change. The findings of these studies indicate that students' goals tend to become more maladaptive over time, might differ for majors and non-majors in lower-level courses, and the factors related to shifts in goals might be more complex in more advanced courses.**

Keywords—achievement goal orientation theory, computer science, undergraduate

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I. Introduction

Goals are a fundamental component of human motivation. They help to direct behavior toward realizing or avoiding some state or outcome not yet attained. They also help determine the effort and resources that should be devoted to a given endeavor as well as criteria for success. In educational settings, learners' goals can be categorized into various *goal orientations* that "refer to overarching purposes of achievement behavior" [1]. Like specific individual goals, goal orientations impact behavior, effort, and strategy use which subsequently impact learning. Goal orientation theories propose that individuals differ in the degree to which they gravitate towards different goal orientations, but individuals typically set and pursue multiple types of goals simultaneously. That is, it is more accurate to think of students as having a constellation of achievement goals with varying levels of importance than as having a single "type" of achievement goal that dominates their motivation.

It has long been known that goals and goal orientations are influenced by context [2], and they can change in response to feedback, failure, changes in the environment, or interventions [3], [4]. Studies of "natural" change, as opposed to change induced by intervention, have been more recent and rarer at the post-secondary level than at the K-12 level. Understanding how students' goals do or do not change during the semester can help instructors better support students in setting or maintaining adaptive achievement goals. This paper aims to provide insight into the natural change of undergraduate CS students' achievement goals.

II. Theoretical Framework

One way achievement goals are categorized is by their valence—the approach/avoidance distinction. All goals are framed in such a way that the individual is either working to attain a desired outcome or to prevent an undesired outcome. Approach goals are characterized by a positively viewed criterion being actively pursued (e.g., working to earn an 'A'), whereas avoidance goals are characterized by a negatively viewed criterion being avoided (e.g., working to avoid an 'F'). Phrased differently, approach goals typically focus on attaining success, but avoidance goals typically focus on avoiding failure.

Achievement goals are also categorized by their focus. Historically, achievement goals were divided into two categories: mastery goals and performance goals. Mastery goals

(also called learning goals) are goals that focus on learning, increasing one's competence, and personal improvement [5]–[7]. The nature of performance goals differs across theoretical frameworks. In some cases, they are characterized by a focus on demonstrating competence in relation to others and being judged by others as competent [7], [8]. In other cases, they are characterized by seeking validation of one's abilities [6].

Empirical evidence supports the distinction between mastery and performance goals [8] as well as a relationship between goal types and differing educational outcomes [9]–[11]. Early work on goal orientations tended to view goals related to grades (e.g., *get an 'A'* or *not fail the class*) as performance goals because of their relationship to competence judgements and validation of one's abilities. Goals related to grades have also been labeled *outcome goals* and been treated as being "outside" the mastery/performance distinction. As a result, sometimes instruments assessing achievement goals have items related to grades as part of the performance goals subscale and other times they are part of other subscales.

Despite the consensus around differentiating between approach and avoidance goals, goal valence is often treated as a secondary characteristic of goals. That is, greater attention is given to the difference between mastery and performance goals than the difference between approach and avoidance goals. The approach/avoidance distinction gave rise to three- [12] and four-factor models [13] of achievement goals. The three-factor model consists of performance approach goals, performance avoidance goals, and mastery goals. The four-factor model contains approach and avoid components for both performance and mastery goals.

More recently, more complex models of achievement goals have been put forth. The 3 x 2 model outlined by Elliot and colleagues [14] categorized goals based on their valence, approach or avoidance, and the definition used to determine competence: task, self, or other. Task-based goals involve a standard derived from the demands of the task: write code that runs as intended (approach), not answer a question incorrectly (avoidance). Self-based goals have a standard derived from one's current or previous competence, such as successfully nesting more loops than previously done (approach) or not scoring worse on this test than the last one (avoidance). The standard of other-based goals is just that—others. These goals are about doing better (approach) or not doing worse (avoidance) than other people.

Shell and colleagues [15], [16] presented a 3 x 2 model that is specific to academic settings and contains elements of the four-factor model and the 3 x 2 model. In their model, performance approach and performance avoidance goals combine the elements of other models: teachers' or peers' judgments of one's competence *and* performance relative to others. Learning approach goals are framed similarly to mastery approach goals, with the focus being on learning course content. Learning avoidance goals, however, are goals to deliberately *avoid learning course content*, rather than to *avoid not learning*, as is the case with mastery avoidance goals in the four-factor model. Finally, task approach goals are goals to complete a given task successfully and are analogous to what was laid out by [14]. For Shell and colleagues, task approach goals include goals to do well on tests and earn a high grade—a departure from the earlier classifications of grade-related goals as performance goals or outcome goals. Task/work avoidance goals are goals to "get by" in a course or complete a task with as little work or effort as possible (see also, [17]). Shell and colleagues' 3 x 2 model is the model that was adopted for the work reported here.

III. Research on Achievement Goals

A. Adaptive and Maladaptive Goal Types

Different types of goals tend to give rise to different types of regulation and affective experiences. Broadly speaking, approach goals and their focus on success tend to bring about positive affect (e.g., hope, excitement) and task commitment. In contrast, avoidance goals and their focus on failure tend to bring about negative affect (e.g., anxiety, fear) and a resistance to commit fully to the task. As such, approach goals tend to lead to outcomes that are more positive and are therefore more adaptive than avoidance goals [10].

Shell and colleagues [15], [16] argue that learning approach goals are the most important type of goal when it comes to students' learning and that, although other types of goals might lead to learning, that learning is largely incidental and is less likely to be lasting. This claim is consistent with the long record of mastery goal orientation leading to better learning outcomes across education levels and settings [10], [18] including CS [19]–[21].

Whether research has found performance goals to be adaptive or maladaptive effects differs according to the theoretical framework applied and the way a given measure operationalizes that goal type [10], [22]. Overall, performance goals defined by demonstrating competence (e.g., to teachers, peers) are associated with lower achievement [10] and maladaptive strategy use (e.g., self-handicapping; [22]), but those defined by interpersonal comparisons and competition (e.g., outperform peers) are associated with higher achievement [10] and adaptive strategy use (e.g., self-regulation; [22]). Students' reason for pursing the goal can also lead to differences in the effects of performance goals. For example, studies have shown that students pursuing competitive goals for controlling reasons (e.g., to impress others) experienced maladaptive outcomes [23], but those pursuing them for autonomous reasons (e.g., to challenge themselves) had adaptive outcomes and higher interest in CS [21].

Relationships with task approach and task/work avoidance goals have been more straightforward. Task approach goals are associated with higher achievement outcomes [24]–[26], and work avoidance goals are associated with lower achievement outcomes [17], [27].

B. Changes in Goals During a Course

As learning and achievement outcomes tend to be top of mind in education, fewer studies have examined natural change in students' achievement goals. As argued by [28], the role goals play in the self-regulation process gives rise to expectations that students' goals for a class might change during the course of a semester. The context at the start of the term (e.g., general excitement, high energy following a break, lack of information about course content or expectations) leads students to set initial

goals that are then revised as the term progresses and the context changes (e.g., additional information about assignments and tests, feedback on performance, stress of multiple classes). Additionally, events outside the classroom (e.g., family crisis, global pandemics) can lead to changes in students' goals.

Research examining changes in undergraduate students' achievement goals during the semester has found mixed evidence for change and stability. For example, using a combination of analytic techniques, [28] found at the sample level, introductory psychology students' mastery approach goals decreased during the semester, performance avoidance goals increased, and mastery avoidance and performance approach goals did not change. However, using the Reliable Change Index (RCI) to test for change at the individual level, they found that an approximately equal number of students showed increases and decreases in mastery avoidance and performance approach goals. In fact, very few students in this study showed no change in their goals, even though the sample-level analysis suggested no average change for some of the goal types. They also did not find any consistent gender differences in goal change. A similar study [29] of introductory educational psychology students and found a similar pattern. Additionally, this study found that performance approach goals were the most stable type and mastery approach goals were the least stable type.

Little research has looked at change using a 3x2 model. In one such study, [25] adopted Shell and colleagues' 3x2 goal framework [15], [16] to examine change in introductory CS (CS1) students' achievement goals. They found that on average, students' performance approach, learning approach, task approach, and performance avoidance goals decreased from the beginning to the end of the semester, and learning avoidance goals increased. Task/work avoidance goals did not change. These changes were consistent across gender, students' year in college, and different course sections.

The purpose of this two-study paper is to examine changes in CS students' goals during the course of the semester from both a group-level and individual-level perspective. This paper extend previous work by using Shell and colleagues' 3x2 goal framework [15], [16] to examine changes in goals for students at all levels of CS courses as well as factors that might be associated with any changes. Study 1 considers change and associated factors for students in 100-level courses, and Study 2 considers change and associated factors for students in upper-level (200 and above) CS courses. The primary research questions addressed in both studies were (1) how do the goals of undergraduate CS students change during the semester? and (2) are changes in goals different for men and women or for CS majors and non-majors? Both studies used mixed ANOVA and the RCI to address these questions.

IV. Method

Survey-based data collection was part of a larger grant-funded study. Data used in this paper were collected from the fall 2014 through spring 2018 semesters. Students were recruited from undergraduate CS courses during the first week of the semester. Participants completed surveys in class during week 1, approximately week 8, and week 15 of a 16-week semester. All surveys were delivered via an online survey platform and voluntarily completed on participants' personal electronic devices during class time. The full battery of instruments given in the surveys can be found in [16].

The instrument of interest for this study is based on the 3 x 2 goal orientation framework first described in [15] and more fully proposed in [16]. This instrument assesses the approach and avoid dimensions of participants' learning, performance, and task goals for a specific course. Items are framed in terms of the *importance* of various goals for the respondent, and the 5-point scale ranges from 1 = very unimportant to 5 = very important. Because of the time constraints of in-class data collection, the pre-survey and post-survey goal orientation measure contained 18 items (3 per scale), and the mid-survey measure contained 12 items (2 per scale). The surveys also asked participants to self-report gender and whether they were considering a CS/computer engineering major or minor. For the latter, participants could respond "yes," "no," or "I am already majoring or minoring in Computer Science/Computer Engineering" and this variable is subsequently referred to as *major status*.

There were 673 participants in Study 1 and 246 participants in Study 2. See Table I for participant demographics. Race/ethnicity data were not collected due to IRB concerns about the identifiability of students belonging to under-represented minority groups. Study 1 participants were recruited from 100-level CS courses (CS1 and CS2) and Study 2 participants were recruited from upper-level CS courses.

All analyses were conducted in SPSS v. 25. Gender and status as a CS major status were explored as possible interacting factors associated with change in goals. Group-level change was tested through a series of mixed ANOVAs. Consistent with the analysis done by [28], individual-level change was examined by using the RCI [30]. Individual-level analysis such as the RCI make it possible to examine the extent to which participants are exhibiting change in differing directions. Whereas analyses like ANOVA only detect change at the sample or group level (i.e., mean change), the RCI compares each individual's change to the standard error of the difference score in order to determine whether the amount of change is greater than what is expected to occur by chance. Because RCI is the mean difference divided by a standard error, it is analogous to a standard score, and cutoffs of ± 1.96 are used to determine significant change.

TABLE I. Participant Demographics

Variable		Study 1	Study 2
N		**673**	**246**
Gender	Men	542	218
	Women	131	28
Year in School	First-year	333	3
	Sophomore	223	102
	Junior	89	78
	Senior	28	63
Considering a CS Major?	Yes	115	47
	No	432	7
	Already a CS Major	126	192

According to [28], a normal distribution of RCI values (i.e., 95% between -1.96 and +1.96) would indicate that any observed change is random. That is the hypothesized distribution that was tested in both studies. See [30] for more information about RCI and how to calculate it.

V. Results

A. Study 1

1) Group-level change

Mixed ANOVA was used to test for change in each the six goal types across the semester (within-subjects factor) and possible moderating factors of gender and major status (between-subjects factors). Due to the constraints of mixed ANVOA, only participants who provided data at all three time points were included in the analyses (n = 469). For all tests, the assumption of sphericity was checked and the Greenhouse-Geisser correction was applied when the assumption was violated, indicated below by non-integer degrees of freedom. Effect sizes for all significant effects are given in Table II (no interaction effects were significant). Figure 1 shows group means for majors, students considering major, and students not considering a major at each time point.

For learning approach goals, the main effect of time was significant, $F(2, 926) = 28.365$, $p < .001$, as was the main effect of major status, $F(2, 463) = 20.498$, $p < .001$. On average, participants ratings of the importance of learning approach goals decreased with time (Time 1 M = 4.34, Time 2 M = 4.09, Time 3 M = 3.80). Tukey's HSD indicated that participants not considering a CS major (M = 3.90) rated learning approach goals as significantly less important than majors (M = 4.35) and students considering a CS major (M = 4.34, ps < .05). No other effects were significant.

For learning avoidance goals, the main effect of time was significant, $F(2, 926) = 12.711$, $p < .001$, as was the main effect of major status, $F(2, 463) = 34.575$, $p < .001$. On average, participants ratings of the importance of learning avoidance goals increased with time (Time 1 M = 2.47, Time 2 M = 2.75, Time 3 M = 2.84). Tukey's HSD indicated that the average ratings of all three major groups were significantly different (ps < .05), with participants not considering a CS major (M = 3.03) rated learning avoidance goals the highest, followed by students considering a CS major (M = 2.34) and then majors (M = 2.05). No other effects were significant.

TABLE II. Effect Sizes for Significant Effects in Study 1

Goal Type	Main Effects		
	Time	Major	Gender
Learn approach	η2 = .058	η2 = .081	---
Learn avoidance	η2 = .027	η2 = .130	---
Perf approach[a]	η2 = .109	η2 = .019	---
Perf avoidance	η2 = .008	---	---
Task approach[a]	η2 = .029	---	---
Task avoidance[a]	---	η2 = .049	---

Note. [a] Greenhouse-Geisser correction applied to within-subjects tests due to violation of the assumption of sphericity. --- indicates non-significant effect. Interaction effects not shown because all were non-significant.

For performance approach goals, the main effect of time was significant, $F(1.957, 906.312) = 56.432$, $p < .001$, as was the main effect of major status, $F(2, 463) = 4.556$, $p = .011$. On average, participants ratings of the importance of performance approach goals decreased (Time 1 M = 3.45, Time 2 M = 3.17, Time 3 M = 2.79). Tukey's HSD indicated that participants not considering a CS major (M = 3.07) rated performance approach goals as significantly less important than participants considering a CS major (M = 3.32). Majors (M = 3.15) were not significantly different than either of the other two groups.

For performance avoidance goals, the main effect of time was significant, $F(2, 926) = 3.802$, $p = .023$. On average, participants ratings of the importance of performance approach goals decreased with time (Time 1 M = 3.16, Time 2 M = 3.04, Time 3 M = 2.82). No other effects were significant.

For task approach goals, the main effect of time was significant, $F(1.967, 910.543) = 13.7$, $p < .001$. On average, participants ratings of the importance of performance approach goals decreased with time (Time 1 M = 4.46, Time 2 M = 4.48, Time 3 M = 4.39). No other effects were significant

For task/work avoidance goals, the main effect of major status was significant, $F(2, 463) = 11.841$, $p < .001$. Tukey's HSD indicated that participants not considering a CS major (M = 2.82) rated task/work avoidance goals as significantly more important than majors (M = 2.28) and students considering a CS major (M = 2.48, ps < .05). No other effects were significant.

2) Individual-level change

RCIs for Time 1 – Time 2, Time 2 – Time 3, and Time 1 – Time 3 were calculated for each participant. Table III shows the proportions of Study 1 participants who showed a reliable increase, a reliable decrease, and no change between each of the time points. All RCI distributions differed significantly (ps < .001) from the hypothesized normal distribution (i.e., 95% within ±1.96). The greatest proportion of reliable change was observed for performance avoidance goals, and that change occurred in both directions. Comparing this result to the ANOVA result, it is clear that despite a small effect size for the mean change in performance avoidance goals, a substantial portion of participants—nearly half—experienced some change. Also of note, despite non-significant ANOVA results for task/work avoidance goals, nearly 20% of students exhibited a reliable change in this type of goal.

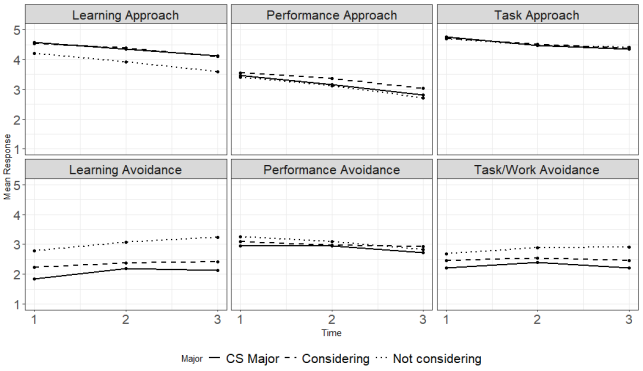

Fig. 1. Change in 100-level Students' Goal Ratings by Major Status.

Chi square tests were also used to determine whether the proportions of participants showing reliable change differed according to major status or gender. Chi square tests of major status were first conducted as a 3 (decrease, no change, increase) x 3 (CS majors, considering, not considering) comparison, but several analyses were deemed inappropriate due to multiple expected cell counts of less than 5. Because of the similarity of means and trajectories for CS majors and those considering a CS major, those groups were combined, and the chi square tests were conducted as a 3 x 2 comparison.

The only significant results for these tests were for change from Time 1 to Time 3. For learning approach goals, more participants not considering a CS major showed a decrease in importance (22%) than did CS majors and participants considering a CS major (13%). For task approach goals, men were more likely to show a reliable decrease than were women (25% vs. 14%).

B. Study 2

Mixed ANOVAs and RCIs were used again for Study 2. Because of the small number of participants not considering a CS major in upper-level courses (n = 2), those not considering a major and considering a major were collapsed into a single "non-majors" group and were compared with participants who had declared a major or minor in CS.

1) Group-level change

Due to the constraints of mixed ANVOA, only participants who provided data at all three time points were included in the analyses (n = 158). For all tests, the assumption of sphericity was checked and the Greenhouse-Geisser correction was applied when the assumption was violated, indicated below by non-integer degrees of freedom. Effect sizes for all significant effects are given in Table IV. Figure 2 shows group means for majors and non-majors at each time point.

For learning approach goals, the main effect of time was significant, $F(1.797, 274.898) = 17.181$, $p < .001$, as was the main effect of major status, $F(2, 463) = 20.498$, $p < .001$. On average, participants ratings of the importance of learning approach goals decreased with time (Time 1 M = 4.46, Time 2 M = 4.10, Time 3 M = 3.88). No other effects were significant.

For learning avoidance goals, no effects were significant. The interaction between time and major status approached significance, $F(1.889, 290.866) = 3.026$, $p = .053$, $\eta 2 = .019$. On average, majors ratings of the importance of learning avoidance goals increased with time (Time 1 M = 2.41, Time 2 M = 2.64, Time 3 M = 2.71), but non-majors demonstrated a weak U-shaped pattern (Time 1 M = 2.59, Time 2 M = 2.38, Time 3 M = 2.55).

For performance approach goals, the main effect of time was significant, $F(1.836, 282.696) = 11.233$, $p < .001$. On average, participants ratings of the importance of performance approach goals decreased with time (Time 1 M = 3.21, Time 2 M = 3.08, Time 3 M = 2.66). No other effects were significant.

For performance avoidance goals, the main effect of time was significant, $F(2, 308) = 5.763$, $p = .003$. On average, participants ratings of the importance of performance avoidance goals decreased with time (Time 1 M = 3.07, Time 2 M = 2.92, Time 3 M = 2.66). No other effects were significant.

For task approach goals, the main effects of time, $F(1.488, 227.650) = 8.636$, $p = .001$, and major status, $F(1, 153) = 13.125$, $p < .001$, were significant. On average, participants ratings of the importance of task approach goals decreased with time, and majors rated them as more important than did non-majors. The two-way interactions between time and gender, $F(1.488, 227.650) = 6.560$, $p = .004$, time and major, $F(1.488, 227.650) = 4.803$, $p = .017$, and gender and major, $F(1, 153) = 9.972$, $p = .002$, were all significant. The three-way interaction was also significant, $F(1.488, 227.650) = 6.066$, $p = .006$. As is shown in Figure 3, women CS majors gave the highest ratings for task approach goals at all time points, and women non-majors gave the lowest. At the beginning of the semester, men CS majors and non-majors rated task approach goals similarly, but by the end of the semester, men non-majors had decreased to a level more similar to women non-majors.

For task/work avoidance goals, the interaction between time and major status was significant, $F(1.836, 282.821) = 5.475$, $p = .006$. CS majors showed an increase in the importance of task/work avoidance goals during the semester (Time 1 M =2.69, Time 2 M = 2.91, Time 3 M = 2.85), but non-majors showed a decrease (Time 1 M = 2.76, Time 2 M = 2.41, Time 3 M = 2.45). No other effects were significant.

TABLE III. RELIABLE CHANGE INDEX RESULTS FOR STUDY 1

Goal Type	Time 1 – Time 2[a]					Time 2 – Time 3[b]					Time 1 – Time 3[c]				
	% decr	% same	% incr	Major χ^2 (2)	Gender χ^2 (2)	% decr	% same	% incr	Major χ^2 (2)	Gender χ^2 (2)	% decr	% same	% incr	Major χ^2 (2)	Gender χ^2 (2)
Learn approach	11.1	86.2	2.7	1.78	2.54	9.6	86.6	3.8	5.40	2.02	18.6	78.8	2.7	8.74[d]	0.03
Learn avoidance	5.2	81.1	13.7	0.35	0.28	7.0	83.0	10.0	4.39	1.65	4.3	76.6	19.1	1.31	1.71
Perf appraoch	10.5	87.1	2.4	0.58	2.25	13.6	83.9	2.5	2.11	5.44	22.9	76.3	0.9	1.26	0.01
Perf avoidance	23.3	60.3	16.3	0.02	0.77	27.2	59.2	13.6	5.30	1.65	32.3	53.4	14.3	3.21	1.67
Task approach	16.2	79.6	4.2	2.77	2.83	15.7	77.9	6.4	1.24	4.00	23.0	73.2	3.8	3.66	7.98[d]
Task avoidance	3.7	85.7	10.5	0.18	3.33	7.4	87.7	4.9	1.00	3.33	7.7	82.0	10.4	4.01	2.12

Note. [a] n = 673, [b] n = 471, [c] n = 560, [d] $p < .05$.

TABLE IV. EFFECT SIZES FOR SIGNIFICANT EFFECTS IN STUDY 2

Goal Type	Main Effects			Interactions			
	Time	Major	Gender	Time*Major	Time*Gender	Major*Gender	Time*Major*Gender
Learn approach[a]	η2 = .101	---	---	---	---	---	---
Learn avoidance[a]	---	---	---	---	---	---	---
Perf appraoch[a]	η2 = .068	---	---	---	---	---	---
Perf avoidance	η2 = .036	---	---	---	---	---	---
Task approach[a]	η2 = .053	η2 = .079	---	η2 = .030	η2 = .041	η2 = .061	η2 = .038
Task avoidance[a]	---	---	---	η2 = .034	---	---	---

Note. [a] Greenhouse-Geisser correction applied to within-subjects tests due to violation of the assumption of sphericity. --- indicates non-significant effect.

2) Individual-level change

Table V shows the proportions of Study 2 participants who showed a reliable increase, a reliable decrease, and no change between each of the time points. All RCI distributions differed significantly (*p*s < .001) from the hypothesized normal distribution (i.e., 95% within ±1.96). Again, the goal type with the greatest proportion of students showing reliable change was performance avoidance goals, with close to half of the sample showing reliable change from Time 1 to Time 3. Similar to Study 1, a substantial number of students showed reliable change in performance avoidance and task/work avoidance goals despite a there being small and non-significant effects (respectively) in the ANOVAs for these goal types.

Chi square tests could not be used to test for differences according to major status or gender because of the presence of multiple expected cell counts of less than 5. Given that no categories could reasonably be combined to resolve this issue, Fisher's Exact Test (3 x 2) was used to test for group differences. Fisher's Exact Test produces a probability rather than a test statistic, so only *p* values for this test are reported in Table V. The interpretation of these probabilities is the same as a *p* value for a chi square test.

There were no differences between men and women. More non-majors than CS majors showed a reliable decrease in learning approach goals from time 1 to time 2 (18.8% vs. 5%) and from time 2 to time 3 (24.1% vs. 6.9%). Non-majors were also more likely to show a reliable decrease in task/work avoidance goals from time 1 to time 2 (16.7% vs. 3.1%), in task approach goals from time 1 to time 2 (22.6% vs. 9.4%), and in task approach goals from time 1 to time 3 (45.2% vs. 22.2%).

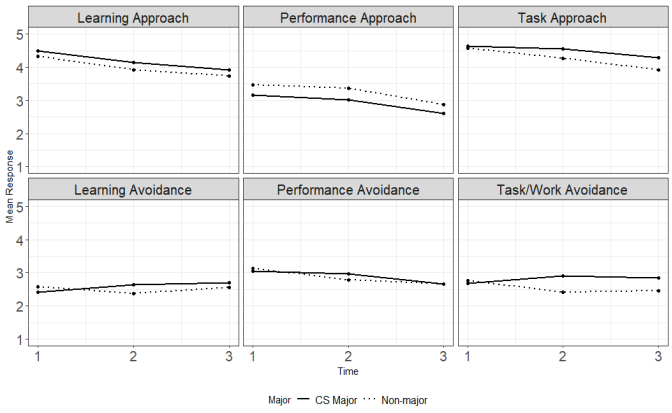

Fig. 2. Change in Upper-level Students' Goal Ratings by Major Status.

VI. DISCUSSION AND CONCLUSION

The results of these two studies indicate there are changes in 100-level and upper-level CS students' course-specific goals during the semester, and some of these changes are what are generally considered to be maladaptive. In the group-level analyses, all approach goals decreased in both studies, the most concerning of which was the decrease in upper-level students' learning approach goals. Using conventional guidelines, the average effect size for average change in learning approach goals was a medium sized in Study 1 and medium-to-large in Study 2. The observed decreases in task approach goals also signal maladaptive change, but in absolute terms, ratings of the importance of task approach goals were still high at the end of the semester. Decreases in the mean level of performance approach goals were observed in both studies and had comparable effect sizes to those of learning approach goals, though mean ratings of performance approach goals were closer to the scale midpoint of "neither important nor unimportant." Given that the measure of performance approach goals used in this study incorporated both the interpersonal-comparison and demonstrating-competence aspects of performance goals, it is not clear whether this change was adaptive or maladaptive. Prior research [25] found no relationship between change in performance approach goals (measured with the scale used in this study) and achievement or self-regulated learning. If prior research showing performance goals contribute to maladaptive

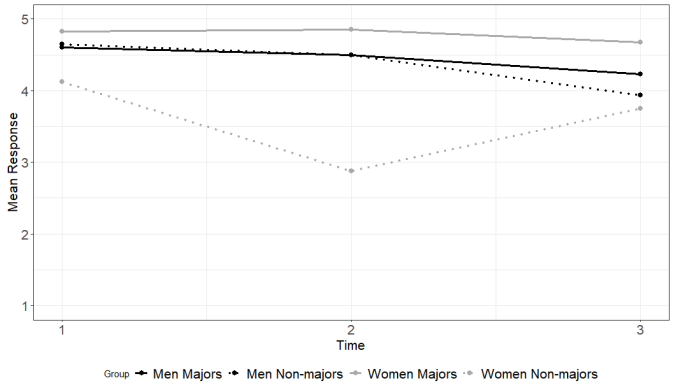

Fig. 3. Change in Upper-level Students' Task Approach Goal Ratings by Gender and Major Status.

TABLE V. RELIABLE CHANGE INDEX RESULTS FOR STUDY 2

Goal Type	Time 1 – Time 2[a]					Time 2 – Time 3[b]					Time 1 – Time 3[c]				
	% decr	% same	% incr	Major *p*	Gender *p*	% decr	% same	% incr	Major *p*	Gender *p*	% decr	% same	% incr	Major *p*	Gender *p*
Learn approach	11.4	87.3	1.2	0.03	0.20	10.2	86.7	3.0	<0.01	0.32	17.1	81.4	1.5	0.07	0.12
Learn avoidance	6.5	81.3	12.2	0.24	0.93	6.6	83.7	9.6	0.92	0.66	7.0	77.0	16.0	0.95	0.53
Perf appraoch	7.3	87.0	5.7	0.74	0.28	18.1	79.5	2.4	0.46	0.68	25.5	69.5	5.0	0.90	0.41
Perf avoidance	19.9	63.4	16.7	0.65	0.71	22.3	68.1	9.6	0.49	0.74	34.0	54.5	11.5	0.14	0.96
Task approach	12.2	85.7	2.0	0.02	0.87	18.8	77.6	3.6	0.16	0.15	27.0	71.0	2.0	0.01	0.52
Task avoidance	6.1	87.0	6.9	<0.01	0.53	6.6	86.7	6.6	0.07	0.39	10.0	79.5	10.5	0.70	0.25

Note. [a] n = 246, [b] n = 166, [c] n = 200.

motivation patterns and lower learning outcomes can be generalized to the present context, viewing performance approach goals as relatively less important and having their importance diminish even further over time might actually be better for student outcomes.

Neither Study 1 nor Study 2 found any overall change in task/work avoidance goals. this finding replicates previous research [25] and suggests that students who start with task/work avoidance goals maintain them, but those who do not, do not adopt them as the semester progresses. However, individual-level analyses revealed small groups of approximately equal numbers of students changing in opposite directions. While the majority seem to maintain their initial level of work avoidance goals, a notable minority do show reliable change. The present research does not provide clear answers as to what might be driving this change. It does suggest that gender is *not* a driving factor, and in upper-level courses, major status might be.

There was greater evidence for change at the individual level than at the group level. Performance avoidance goals were the "big movers" in both studies, with about one third of students demonstrating a reliable decrease and a smaller but still notable portion of students showing a reliable increase. Change from the beginning to the end of the semester for the six goal types was quite similar across the studies: most students showed no reliable change, but there were more decreases than increases for all approach goals and performance avoidance goals, and there were more increases than decreases from learning avoidance goals. For task/work avoidance goals, there were slightly more participants who increased than decreased in Study 1 and the proportions were nearly identical in Study 2.

In Study 1, the group-level analyses detected differences associated with major status for three of the six goal types. For learning approach, learning avoidance, and task/work avoidance goals the effect of major was driven by students not considering a CS major. The difference in learning approach goals also showed up in the individual-level analysis, where participants not considering a CS major were more likely to show a reliable decrease. Overall, these students showed a more maladaptive pattern of motivation: lower learning approach goals and higher learning and task/work avoidance goals. However, for performance approach goals, students considering a CS major rated these goals as more important than non-majors. It is possible that students who are considering a CS major have a stronger interested in normative comparisons than students who are not considering a CS major because they are seeking additional feedback about how they would "fit" relative to their peers if they were to continue in CS. It is not difficult to see how a student might believe, "If I am going to be a CS major, I should probably do better than most in this introductory course." From this perspective, this kind of normative feedback would be less important to students who are not considering taking additional CS courses.

In Study 2, the only group-level difference associated with major status was for task approach goals. Individual-level analyses also detected differences between majors and non-majors for learning approach goals and task/work avoidance goals. At the beginning of the semester, the task approach goals of upper-level CS majors and non-majors were similar, but by the end of the semester they were more than a quarter-point different (on a 5-point scale). This could reflect an increase in non-majors' focus on other courses, perhaps courses in their major, as the semester draws to a close and final projects and exams demand more time and attention.

Consistent with prior research [25], [28], there were few differences between men and women in either of these studies. The time X gender interaction and the three-way interaction of time X gender X major status for task approach goals in Study 2 warrant further investigation. The small numbers of women in this study raises the possibility that this finding might be unique to this sample, but future research should look more closely at shifts in the task approach goals of women in upper-level CS courses.

Despite the overall maladaptive trends identified in these studies, students' average ratings of the importance of the various goal types were encouraging. Learning approach and task approach goals had the highest average ratings at every time point, and approach goals were overall more important to students than were avoidance goals. This suggests that instructors interested in supporting adaptive achievement goals might best use their energy to encourage and reinforce students'

adaptive learning and task approach goals, rather than try to "fix" maladaptive goals. The challenge for instructors seems to be to support and maintain what students bring to the classroom rather than to try to impose change after they arrive.

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