WIP: Applying Self-Regulated Learning Principles in an Undergraduate Computer Science Seminar

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***Abstract*—This work-in-progress research-to-practice paper describes a new computer science (CS) course that provides undergraduates an opportunity to grow their metacognitive and CS skills through self-regulated learning and specifications grading principles. It is motivated by the students' need to stay relevant post-graduation in the rapidly evolving field of CS. However, a traditional CS curriculum provides few formal opportunities for students to navigate their own learning processes. By the end of this course, students will have acquired new CS skills and be better prepared for lifelong CS learning as active, reflective, self-guided learners.**

***Index Terms*—Computer science, Student perception, Self regulated learning**

I. Background

This work-in-progress research-to-practice paper describes a new computer science (CS) course, "Peer-Led Seminar in Tech," that provides undergraduates an opportunity to grow their metacognitive and CS skills through self-regulated learning (SRL) [1] and specifications grading principles [2].

The course is motivated by the students' need to stay relevant post-graduation in the rapidly evolving field of CS. The field of CS constantly changes and requires CS researchers and professionals to continuously adapt and learn throughout their careers. CS professionals are required to learn new technologies, languages, and frameworks to remain competitive in the industry [3]. Therefore, it is critical that CS curriculum provides students the learning skills necessary to sustain continued professional growth beyond graduation. However, a traditional CS curriculum provides few formal opportunities for students to navigate their own learning processes.

Self-regulated learning (SRL) is an active, reflective process in which a learner monitors and controls their own learning [4]. SRL involves students: considering their task, planning and setting learning goals to complete the task, using strategies to meet their goals, monitoring their goal progress, and adapting their learning process when goal progress is deemed insufficient. Students who develop SRL skills and practice implementing SRL processes before graduation become more reflective, adaptive, and ultimately more effective learners [5].

Specification grading [2] complements SRL by providing students with clear expectations and standards to achieve particular grading thresholds. This approach also allows for flexibility in how students achieve those expectations and outcomes. In the context of this peer-led seminar course, specification grading is a framework that supports student autonomy and naturally supports the SRL framework by providing students with guidelines to plan and set personal and specific course-related goals.

The combination of SRL and specification grading in this course creates a unique educational environment where students simultaneously develop technical CS skills and metacognitive skills and knowledge. Students have agency in selecting their own learning paths while receiving structured practice and support in goal-setting and monitoring, strategy implementation, and adaptation. This approach helps bridge students' experiences in traditional academic environments with the self-directed roles they will encounter as CS professionals in industry.

II. Research-to-Practice

In the following sections, we discuss the various ways in which the research related to SRL and Specifications Grading has impacted the design of our course. That is followed by the details of the implementation of the research principles in practice in the course.

A. Self-Regulated Learning (SRL)

SRL is an active, reflective, and adaptive process in which a learner monitors and controls their own learning through enacting strategies to achieve their goals. Figure 1 shows how SRL unfolds over four phases: (1) develops an understanding of the task, (2) makes a plan and sets goals, (3) enacts learning

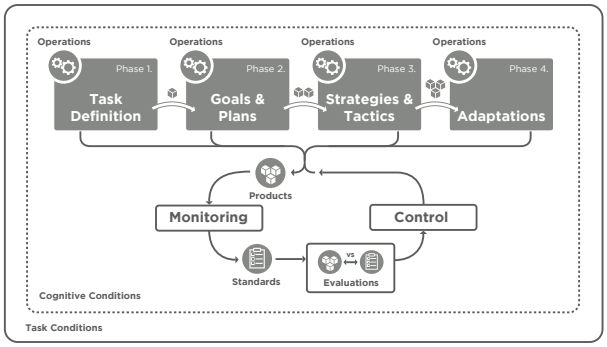

Fig. 1. Illustration of self-regulated learning (SRL) phases [6]. Figure reprinted with permission from Urgo 2023 [7].

TABLE I
FINAL GRADE SPECIFICATION

Letter	Requirement	Description	Pass	Excel
D–	Attendance	Percent of classes attended on-time.	70%	90%
	Participation	Earned participation average.	70%	90%
C–	Skills	Completed hours learning CS skills.	12h	16h
	Group Lecture	Delivered in-class group lectures.	1	N/A
B–	Events	Completed hours attending CS events.	4h	8h
	Mini Lecture	Delivered in-class mini lectures.	1	2
A–	Stretch	Completed extra stretch requirements.	1	2

strategies, and (4) makes adaptations based on outcomes [6]. Prior work has found that SRL processes are predictive of academic performance and learning [5].

Across the phases of SRL, goal-setting plays a critical role. First, goals prompt learners to consider their task understanding. Second, goals direct attention toward planning the learning task and goals influence strategy choice for achieving goals. Third, goals provide standards for monitoring and evaluating progress [8]. Standards are the criteria for understanding when a goal has been met (e.g., write *four different functions that use HTML elements* in JavaScript without external sources).

Across a wide range of prior work, SRL has been found to play a critical role in learning achievement broadly [9], [10], [11], as well as for CS students learning programming specifically [12]. Importantly, SRL is domain-agnostic and, in terms of lifelong learning, is critically important as SRL skills can be applied to learning any new topic or discipline in CS.

B. Specifications Grading

Specifications grading [13] is an alternative grading [14] practice that provides students with the agency to choose their own grade for every assignment, in turn, the entire course. Instructors provide clear *specifications* informing students what they need to accomplish to get a specific letter grade on an assignment. The specifications for a higher grade include higher expectations in terms of the work and time required to obtain that grade. Student grades are determined by the students, who choose the amount of effort they want to put in.

In terms of grading, there is no partial credit and students receive the grade for the work that they completed if it meets all the specifications. This shifts focus away from earning points towards learning goals. Research has shown that specifications grading leads to increased motivation, decreased anxiety about partial credit, and higher responsibility among students about their own learning [2].

We incorporated specifications grading into this course to encourage students to own their learning process and develop a sense of self-regulation as it relates to goal setting and adjustment.

C. Implementation in Practice

We applied research from self-regulated learning and specifications grading in the course "Peer-Led Seminar in Tech," which is a 2 credit 16 week 200-level special topics elective course that undergraduate CS majors may optionally take after completing their 100-level CS courses. The students in the course are expected to "practice self-learning new technical CS skills, organize and run activities that strengthen the tech or CS community within the classroom, as well as participate in activities that engage with the tech or CS community outside the classroom."

The base letter grade is determined by the grade specification, depicted in Table I. Each letter grade adds *additional* requirements on top of the previous letter grade. For example, to earn a C– letter grade, students must attend 70% or more of classes on-time, earn a 70% or higher average on participation assignments, complete 12 hours learning CS-related skills, and deliver 1 group lecture in-class. To earn a letter grade without the minus modifier, students must excel in at least 1 requirement of their choice. To earn a plus letter grade, students must excel in at least 2 requirements for a D+ and at least 3 requirements for a C+, B+, or A+ letter grade.

The grade specification provides both the foundation and flexibility needed to support the SRL process for students. Students must decide which requirements to pass or excel in, as well as make weekly progress on those requirements. Therefore, they must learn to set goals, enact strategies to achieve those goals, and adapt those strategies over the semester. Specifically, the specification itself in Table I defines the tasks students must accomplish by the end of the semester for phase 1 of the SRL process, and provides clear measurable standards for goal setting in phase 2.

Participation assignments throughout the semester help students plan how they will meet the requirements for phase 2, select strategies for phase 3, and adapt their strategies for phase 4. This includes a goal-setting assignment in week 4 and check-ins during week 7 and 14 to make any necessary adjustments. Finally, weekly reports and reflection assignments with prompts adapted from McCardle et. al [8] and Hadwin et. al [15] serve the role of the metacognitive monitoring and control loop with each SRL phase.

While the course is designed to encourage and support SRL, students are never formally introduced to the concept. Students are given a single lecture on goal setting and reminded the qualities of effective goals in their assignment prompts. They only receive feedback on their goals and progress during brief 1:1 check-in meetings with the instructor during week 7 and 14. The rest of the class is dedicated to other CS-related content.

III. METHOD OF ASSESSMENT

We first identify our research questions, then discuss how we will use formative assessments such as reflections, check-ins, and a questionnaire on SRL practices [15] to answer those questions. We also plan on a summative assessment based on the goals met by the students, along with a meta-analysis of their reflections.

A. Research Questions

We are investigating the following high-level research goals in this work-in-progress research-to-practice study. First, we

explore the impact of the course on students acquiring new CS skills. Second, we explore the impact of the course on students using active, reflective learning processes. Additionally, we explore *how* these SRL learning processes affect student learning outcomes (i.e., CS skills achieved).

To concretely explore our research goals, we are investigating the following research questions (RQs):

RQ1: What is the impact of specifications grading requirements on goal-setting?

RQ2: What is the impact of the specifications grading requirements on goal achievement?

RQ3: What is the impact of active, reflective learning on goal achievement?

RQ4: What kinds of challenges affected goal achievement?

RQ5: Did students monitor their learning progress by adjusting their goals?

RQ6: Did students acquire new CS skills?

In the following sections, we first discuss our preliminary mid-semester data collection and how we use that data to provide preliminary findings for RQ3, RQ4, and RQ5. We then discuss how we will use our full semester data to answer RQ1 and summative assessment to answer RQ2 and RQ6.

B. Preliminary Data Collection

Figure 2 provides the goal setting and reflection prompts given to students up to week 10. We introduced a goal setting lecture in week 4 of the class and set aside time in-class for students to complete a goal setting assignment. That same week, we modified their weekly reports to include 'prompts setting' and reflecting on weekly goals. In week 7, students were required to complete a mid-semester goal reflection assignment and attend a 10 minute 1:1 check-in with the instructor. Students receive feedback from the instructor on their goals and progress during the check-in, but not on the weekly reports.

We exported the anonymized responses into a spreadsheet. The qualitative analysis was conducted by two researchers who reviewed 100% of the data. All disagreements were resolved by both researchers during the qualitative analysis process.

C. Preliminary Assessment

Using the responses from the week 7 goal reflection assignment described in Figure 2, we are able to perform preliminary assessment on the impact of active, reflective learning on mid-semester goal achievement (RQ3), the challenges that affected this goal achievement (RQ4), and whether students monitored their learning progress by adjusting their goals (RQ5).

To measure RQ3, we analyzed student reflections in the "Mid-Semester Goal Status" prompt regarding their goal progress. Specifically, for each goal reported by a student, we categorized the goal progress as none (0%), limited (below 50%), moderate (at or above 50%), or complete (100%). Then, for each student, we counted the number of mid-semester goals originally set, and the percent of those that were categorized as none, limited, moderate, or complete.

We analyzed student responses to the fixed-choice "Encountered Challenges" questionnaire for RQ4. Specifically, we counted the number of times a challenge was listed as "Agree" or "Strongly Agree" across all responses and the number of challenges identified per student. We also sampled responses from the open-ended "Overcoming Challenges" prompt.

Finally, for an initial analysis of RQ5, we examined the adjustments students made to their goals in the last two "End-of-Semester Goal" prompts on progress and adjustments. For each student, we counted the number of end-of-semester goals originally set, the percent of those goals that they improved, the percent of those goals that were replaced with a different goal, and whether students indicated a change in strategy to achieve those goals in their response.

D. Planned Assessment

In addition to the assignments described in Figure 2, we plan on another goal reflection assignment in week 14 and a final report due at the end of the semester in week 16. We will also continue to collect their weekly report responses until the end of the semester. Finally, we will collect how well students performed in the class based on the grade specification in Table I. We will export the anonymized responses into Taguette [16] to manually code each response and use this updated data to re-assess our research questions.

Our first research question RQ1 explores the impact of specifications grading on goal setting. To answer this question, we will analyze the goals students set during class. Specifically, we will compare the criteria provided in the specifications grading (e.g., completed hours attending CS events or learning CS skills) to the standards set in student goals (e.g., spend two hours at an ACM speaker event or working toward a deep learning certificate). Alignment of the two indicates that specification grading was successful in giving students a clear framework for setting goals for achievement in the course.

We will use summative assessment for RQ2 and RQ6. To answer RQ2 on the impact of specifications grading on goal achievement, we will analyze the total number of goals completed per student. To address RQ6 on the skills acquired, we will count the number of hours students spent on learning CS skills from their weekly reports and the number of official certifications they earned.

We also plan to update our preliminary analysis for RQ3, RQ4, and RQ5. Specifically, we used mid-semester week 7 goal reflections to answer RQ3 on goal achievement and RQ5 on goal adjustments. We will expand our analysis for both questions to include responses from the entire semester and explore how these values change over time. We will also expand our findings for RQ4 on the challenges encountered with a qualitative analysis of the open-ended responses and compare the most common challenges identified to those from our preliminary analysis.

IV. Preliminary Findings

In this section, we report on our preliminary findings for RQ3, RQ4, and RQ5 from the questionnaire items and qualitative

WEEKLY REPORTS (WEEK 4 TO WEEK 10)

- **Goal Planning:** What is one learning goal that you plan to achieve for the upcoming week? Remember to include a specific action, content, timeframe, and measurable criteria.
- **Goal Reflection:** Reflect on your goal from the last report. Did you meet your criteria within the timeframe? What went well? What could be improved moving forward?

WEEK 04 LEARNING GOALS

The following questions will ask you to list your learning goals for this class. Please format your goals using a bulleted or numbered list.

Try to make your learning goals as specific as possible with measurable criteria. You are encouraged to list several goals for each question, but must have at least 3 goals per question to earn full credit.

- **End-of-Semester Goals:** Please list more than 3 learning goals that you hope to achieve by the end of the semester.
- **Mid-Semester Goals:** Please list more than 3 learning goals that you hope to achieve by mid-semester (i.e. by Spring Break).

WEEK 07 LEARNING GOALS

The following questions will ask you to reflect on the progress you have made on the learning goals you set earlier this semester, and make adjustments if necessary depending on your progress. Please try to spend at least 15 to 30 minutes on this assignment.

- **Mid-Semester Goal Status:** Reflect on your progress on your mid-semester goals from the previous question.

  If you finished a goal, congratulations! Do not forget to celebrate your wins and reflect on what worked well. If a goal is still in-progress, it happens! This is a natural part of the goal-setting process; do not beat yourself up. Either way, it is important to reflect and learn from the experience.

  For each of those mid-semester goals, please answer the following questions in 1 to 3 sentences per answer per goal:

  a. Estimate how close you are to achieving this goal (e.g. 100% if finished) and describe the criteria you are using to measure the goal progress.

  b. Reflect on whether your goal itself could have been improved. Was the goal too easy or difficult? Was the timeframe too short or long? Was the goal specific enough, with a specific cognitive action (e.g. identify, evaluate, apply, summarize), content, and measurable criteria?

  Make sure to clearly indicate the goal you are talking about in the text.

- **Encountered Challenges:** The following are things that can make studying and learning at university difficult. Think about how you progressed so far on your mid-semester goals, and rate your level of agreement with each statement.

  As I progressed on my mid-semester goals, I struggled with...

- **Overcoming Challenges:** Describe the problems, obstacles, or challenges you encountered while working on your planned mid-semester learning goals? For each, describe whether you were able to overcome them and how.
- **End-of-Semester Goal Progress:** For each of your planned end-of-semester goals, reflect on whether you are on-track to achieve those goals based on your mid-semester progress in 1 to 3 sentences. Remember to consider the goal criteria that you are using to measure that progress.
- **End-of-Semester Goal Adjustments:** Given your responses thus far, make adjustments to your planned end-of-semester learning goals and list your new goals below.

  Try not to abandon a learning goal; instead, try to improve or adjust the goal. Remember, from our Goal Setting discussion, effective goals are difficult, specific (with a specific cognitive action, content, measurable criteria, and short-term timeframe), and learning-oriented.

Fig. 2. Prompts from goal setting and reflection assignments up to week 10. The weekly planning and reflection prompts are adapted from McCardle et. al [8] and the challenge prompts are adapted from from Hadwin et. al [15] with options: Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree.

analysis of open-ended responses. We found that despite a brief introduction to goal setting, limited feedback on goals, and no formal introduction to the SRL process, students are practicing SRL and making progress towards their goals.

A. Demographics

We collected responses up to week 10 from a total of 15 students enrolled in the Spring 2025 section of the course, with approximately 27% sophomores, 33% juniors, and 40% seniors. Approximately 33% of the class are women, and approximately 33% belong to a race or ethnicity underrepresented in CS.

B. RQ3 Monitoring Goals Toward Goal Achievement

RQ3 aimed to determine the impact of active, reflective learning on goal achievement. We found that most students were able to complete at least half of their mid-semester goals. Specifically, 73% of students were able to fully complete at least one goal and 53% were able to complete at least half of their goals. For example, one student set a goal to "participate in (and complete) a hackathon" and wrote "I did it!" followed by an excited description of their experience.

However, no student completed all of their mid-semester goals and 47% of students made no progress on one or more goals. For example, one student set a goal to "obtain two or more certifications from LinkedIn learning" and reported their lack of progress as "I have not started any LinkedIn certifications" followed by a discussion of why.

C. RQ4 Challenges Toward Goal Achievement

RQ4 aimed to identify the types of challenges affecting goal achievement. Figure 3 shows the top challenges from the questionnaire faced by the students as they worked towards their goals. Findings show that students identified *procrastinating*, *motivation*, and *adjusting study skills* among the most common challenges faced.

We also looked at the open-ended responses for students that agreed with the top challenges. For example, one student who strongly agreed that *procrastinating* was a challenge wrote, "I definitely struggled a lot with procrastinating and just beginning to work on assignments." Another student who agreed that *motivation* was a challenge wrote, "the main problem I've come across so far this semester is having motivation to do learning courses when I could spend my time on work that needs to be done for other classes (more immediately necessary goals) or things that I enjoy." Finally, another student who agreed that *adjusting study skills* was a challenge wrote, "the challenges for me were to figure out how to best learn my material from my skills criteria."

Students reported they agreed or strongly agreed with 9 challenges on average and as high as 17 out of 31 possible challenges. Only 1 student reported 0 challenges on the questionnaire, but mentioned procrastinating in their open-ended text. This student completed or nearly completed all of their mid-semester goals.

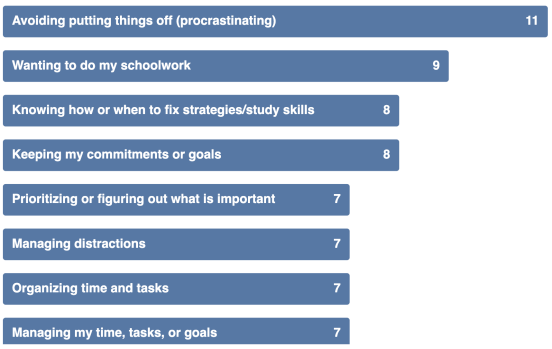

Fig. 3. The top challenges faced by the students when they reflected on why they were not able to meet their goals.

D. RQ5 Monitoring & Goal Adjustment

RQ5 aimed to determine whether students monitored their learning progress by adjusting their goals. We found that 80% of students made some kind of adjustment to their original end-of-semester goals. Specifically, 73% of students improved at least one of their goals and 33% of students replaced at least one of their goals with something different. However, only 20% of students also mentioned adjusting their strategy towards achieving their goals in their reflections.

For example, one student reported an original goal of "complete one other LinkedIn learning course (I want to learn a new technology or language)," and then improved the goal to be more specific by specifying they wanted it to be a course on Swift. Another student changed from the goal of "Learn C++" to "Understanding how to apply qiskit to a project" instead. One student kept their goal to "improve my attendance before class" but specified a strategy adjustment to "keep better track of it and count how many classes or events I am late for" to improve their statistics each week.

V. Implications

While our results are preliminary, our analysis shows that students are engaging in the SRL process despite receiving minimal formalized training and feedback. Most students have already been successful in achieving at least half of their mid-semester goals, are able to identify challenges affecting their ability to achieve their goals, and make adjustments to improve their end-of-semester goals accordingly.

By successfully scaffolding SRL within this course using specifications grading, students are able to strengthen both their CS skills and the transferable metacognitive skills essential for continuous professional growth. This positions students for *lifelong learning*, key for success within the rapid and complex advancements of the CS industry.

The implications go beyond preparing students for the realities of their professions post-graduation. We show that parts of the SRL process can be sustainably integrated into an existing CS course with students ranging from their first to senior years, suggesting it can be integrated at any level of the curriculum. However, our results suggest instructors need to dedicate at least one lecture on goal setting and assign regular reflection assignments. Most of those do not require instructor feedback, except for the first and mid-semester assignments. While we found that SRL and specifications grading worked particularly well together, we believe SRL can be integrated into any course with measurable learning outcomes regardless of the grading approach.

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