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A Survey of Task Planning: Pre- and Post-Assessment of a Project Management Activity in the Computer Science Senior Capstone

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Abstract: Task planning is a foundational project management activity in North Carolina State University's Computer Science (CS) senior capstone wherein student teams collaboratively outline their preliminary requirements and system architecture along with an early vision of implementation and testing. However, there are currently no student-centered assessments designed to evaluate which task planning activities teams find more effective and which they perceive as less effective to their learning process. To address this gap, I have developed a Pre-Task Planning Survey (Pre-TPS) to gauge students' perceptions of course activities and team cohesiveness *prior* to the project management activity, and a Post-Task Planning Survey (Post-TPS) to evaluate their approaches to task division and project scoping *after* the activity. This paper describes the steps taken to develop and deploy the surveys to 70+ student learners across two sections of Senior Design during the Fall 2024 semester. Results are presented along with a qualitative analysis of student feedback. Considerations for improving the surveys and their implications on future sections of the capstone are also discussed.

Keywords: Computer science capstone, senior design, teamwork, task planning, project-based courses, project management, collaborative learning, project scoping

1. Introduction

Demonstrating proficiency in various systems, tools, and programming languages — while these technical skills are indeed an integral part of the computer science curriculum, with the rise of ChatGPT and other LLMs, the so-called 'soft skills' of team-based communication and collaboration are sought after now more than ever amongst industry professionals [1]. In other words, knowing how to work as part of a team and present their work to different audiences is just as important as knowing Python or Java for today's software engineers. The Computer Science (CS) Senior Design capstone at North Carolina State University has embraced this mindset from its inception via task planning, a project management activity wherein teams collaboratively outline preliminary requirements and system architecture along with an early vision of implementation and testing, "including estimating hours, defining project scope . . . clarifying project deliverables, and maintaining follow-through" [2].

Interestingly, task planning began almost by accident. During the first decade of the CS capstone's existence at NC State, one four-person student team asked for a meeting with faculty in order to find out why they were having a breakdown in their communication. The teaching staff soon discovered that the students had divided the project into four discrete modules, each team member assigned to a different task they would complete in solitude from one another, with the plan being that the team would gather in the final weeks of the semester to patchwork their four modules together into a cohesive final project [3]. After the faculty worked with the students to reframe their iterations in terms of features, consider dependencies, and plan peer programming tasks, the team came away from the experience — our department's very first task planning session — with a renewed vision for their project and a more effective, team-centric approach. The team continued to revisit the exercise, the experience not only creating a greater sense of camaraderie among the students, but producing what was arguably one of the most

successful projects that semester. Asking themselves how other teams could benefit from this activity even when they were not dealing with communication issues, the Senior Design teaching faculty began inviting all teams to participate in this project management activity. Today, task planning is an indispensable part of the Senior Design curriculum.

While faculty have facilitated task planning sessions for nearly 1,000 student teams over the past quarter century, there have been no assessments designed to evaluate which learning activities within task planning teams find more effective and which they perceive as less effective to their learning process. As part of continuous efforts to meaningfully reflect on and evaluate task planning as it relates to active learning practices in Senior Design, I have implemented a Pre-Task Planning Survey (Pre-TPS) and a Post-Task Planning Survey (Post-TPS), the Pre-TPS designed to be completed by students in the first few minutes of the task planning session and the Post-TPS designed to be completed in the last five minutes.

The Pre-TPS questions gauge learners' perceptions of course activities and team cohesiveness *prior* to task planning, while the Post-TPS is designed to evaluate learners' approaches to task division and project scoping *after* the activity. This paper describes the steps taken to develop these surveys, including privacy and validity concerns, for what we feel is a pivotal project management activity in the CS capstone. These steps included deploying the surveys to approximately 70 student learners across two sections of Senior Design during the Fall 2024 semester. Results are presented along with a qualitative analysis of student feedback. Student responses have been anonymized given the small sample size because providing demographic information such as gender identity and ethnic background would identify certain individuals and invalidate the research-exempt status of this project's IRB. Considerations for improving the surveys for future research and integration into all sections of the capstone are also discussed.

2. Background

The Senior Design capstone is unique among courses offered in both our department and in our university's College of Engineering because it is team-taught by professors with backgrounds in computer science (technical advisors) and technical writing and speaking (communications advisors). It has embraced this interdisciplinary model from its inception [4]. Not only do students gain real-world experience developing proofs-of-concept, educational games, or software prototypes for sponsors in the tech, education, and nonprofit sectors, but it is in this course that they have the opportunity to integrate all of the skills they have learned during their undergraduate curriculum. Moreover, NC State University's location in Raleigh, North Carolina, is ideal for project sponsors, this growing metropolitan area in the Southeastern United States known for tech start-ups and established software companies alike. Over the past three decades, hundreds of companies have mentored thousands of students, the course that was once an elective with just five teams of students now an ABET-accredited graduation requirement with nearly fifty teams of students as of Spring 2025.

All Computer Science students at NC State are required to pass Senior Design in order to graduate, with a majority of them taking the course during the fall or spring semester of their final year. The class reinforces concepts introduced in foundational courses such as Software Engineering, a prerequisite for Senior Design which students typically take during their third year. Like Software Engineering, Senior Design is a project-based course centered around

iterative development: learning how to write and refine requirements; how to design, implement, and test an object-oriented system; and how to appropriately scope a project into manageable tasks, with teams collaborating on all documentation and deliverables. As a team-based course, Senior Design operates under a learner-centered paradigm where students lay out their own team ground rules, define and rotate roles, and direct the pace of their iterations under the guidance of instructors who serve in more of a mentor–facilitator capacity than as an expert.

In Senior Design, the team formation process occurs during the first week of the semester. Instructors distribute a Google form to students, inviting them to rank their top three projects in order of preference. The forms also ask students to describe previous coursework, research experiences, and internships that might help us with team formation, and there is space for students to list team members they would like to work with as well as individuals they would prefer not to work with. The teaching team then uses these forms to build five-person teams that satisfy at least some of the listed preferences, with students usually getting one or more of the teammates they wanted to work with and/or one of their top projects.

During the second week of the semester, the newly-formed teams participate in "kickoff meetings" where students meet their sponsors for the first time and have a chance to ask questions in order to clarify the problem statement and to help them define their requirements. Prior to their kickoff meetings, student teams develop an agenda that they send to their sponsors 24 hours in advance. These meetings then continue throughout the semester. Student teams, sponsors, and the teaching staff stay connected outside of class via email and Slack, where learners can ask questions or get feedback on blockers between weekly meetings.

Classes meet twice per week on either Mondays/Wednesdays or Tuesdays/Thursdays. During the Fall 2024 semester, from which this paper derives its data, students across five sections of Senior Design bid on over 30 projects, with topics ranging from software engineering to education, games to cybersecurity. For a bit more background, students meet in the Senior Design lab during class time to work with their peers on sponsor- and team-defined deliverables. Lectures are presented on the course Moodle site, with students invited to watch them and complete any associated interactive quizzes by a specific week of the semester. Because of the flipped curriculum, the technical advisors are freed up to provide guidance on teams' choice of technologies, tools, implementation, and testing week-by-week. Similarly, the communications specialists are available to advise students on details related to professional writing, delivering presentations, and team project management. Both the technical and communications co-instructors give feedback to students during team check-ins, modeled after industry stand-ups. Senior Design sponsors also mentor teams through weekly meetings lasting 30–60 minutes, with the majority of these meetings occurring during class time.

This interdisciplinary model emphasizes the importance of collaboration, communication, and team project management alongside the software development lifecycle. Just as the technical advisors work with students as they move from writing individual lines of code to crafting the backend of their project, for instance, communications faculty work with students on communicating professionally with their sponsors in agendas and in documentation, helping them to envision how these writing moments go on to inform their substantive, team-authored technical report. And, as the technical advisors encourage teams to think about different users interacting with their system, the communications specialists inspire teams to think about

different audiences as they design their presentations. Creating a continuous feedback loop and structuring the course through thoughtfully scaffolded learning experiences that blend writing, speaking, and teaming alongside software engineering milestones not only reinforces CS learning outcomes, but facilitates the transition from university to industry or graduate school [5].

3. Methodology – Surveying the Task Planning Experience

Taking place sometime between weeks three through five of the semester when teams are still gelling, task planning is an active learning, hour-long whiteboarding session that is tailored to each individual team. The session itself is facilitated in a dedicated space across from the Senior Design lab replete with a whiteboard and accessible touchscreen, a large table for the team to gather around, and access to drafting supplies such as paper and markers. For a clearer view of task planning, I provide the following timeline of how we facilitate a typical session:

- **0–5 minutes:** Greet teams and welcome them to task planning. Provide a bit of context/history of the activity and an overview of the session's goals.

- **5–10 minutes:** Have students collaboratively fill out the team's project timeline on the whiteboard using course due dates and noting check-in days, sponsor meetings, team- or sponsor-driven deadlines, etc.

- **10–20 minutes:** Definite preliminary requirements (or refine them/elaborate on features for teams that have already developed a list of requirements). Group requirements by iterations. For traditional software projects, teams might opt to express requirements functionally, as use cases, or as user stories. For games projects, teams will need to define the genre of the game, who the playable characters are, and the goal(s) of the game (may include win/lose conditions), in addition to gameplay rules and mechanics. Reflect on accessibility as part of this process.

- **20–30 minutes:** Invite students to come up to the board and sketch their high-level design. For traditional systems, consider *who* their users are and *how* they interact with the system: frontend, backend, and database. Design should be accessible and inclusive, and teams are encouraged to have these conversations and make notes/sketches according to these principles. For games projects, consider an alternate visual such as an AGE diagram. A paper prototype might also be useful.

- **30–40 minutes:** Now that preliminary requirements and design draft have been touched on, discuss how implementation tasks will be divided up. Will sub-teams of two students work on Feature A and Feature B, with the fifth team member going between the sub-teams? Will one student be working on character design as two students are creating the game environment, and the other two students are working on the game's turn-based algorithm? How long will a particular task take — 2 hours or 10 hours? Will the team be working in sprints or in iterations?

- **40–45 minutes:** Brainstorm other design pieces relevant to each team's project. For instance, a traditional system might lead to a class diagram of the backend or an entity-relationship diagram of the database. Games projects might lead to discussions about art assets or a state diagram of the gameplay loop.

- **45–50 minutes:** Look ahead to testing. Teams should think about acceptance tests, discuss what testing suite they will use for unit tests (if appropriate), and think about other forms of testing (i.e. usability or playtesting).

- **50–60 minutes:** Wrap up any loose ends from the task planning session. Engage students in a final reflection, perhaps with the aid of sticky notes, where they can jot down "sticking points" they want to make sure to

> cover before we conclude. Thank the team for a great task planning session and have students gather up paper prototypes or notes and take photos of the whiteboard so they can refer to it, share with sponsors, etc.

Teams designing a more traditional system for their sponsors will have a much different set of functional requirements than teams creating an educational game, for instance. One team might be thinking through their requirements as a series of user scenarios, so user stories make the most sense as a way to convey requirements, while another team might choose to express requirements traditionally.

After a thorough exploration of requirements, teams turn to design, with a group working on an educational game project envisioning their high-level design through an Action Gameplay Experience (AGE) diagram, while teams working on a data analysis project for their sponsor will sketch out a frontend, backend, and database for their high-level design. Students work together to draw this on the whiteboard. But no matter the diagram, we ask teams to think about accessible design practices, even at this early stage. Are their game's art assets in an accessible color palette? Is there a high contrast between their title screen and background?

Assessment-wise, task planning is only "graded" insofar as it is part of students' participation grade. This means that it serves as a low-stakes learning opportunity for each team. We try to schedule most task planning sessions during class time, opposite students' sponsor meetings and check-ins with the teaching faculty. After each team has had the opportunity to create a timeline for their first iteration(s), scope their project, write requirements and envision an accessible design, estimate hours and divide implementation tasks, and look ahead to testing, we often perceive a new sense of energy in the Senior Design classroom. Team dynamics also shift toward greater camaraderie, this synergy owing much to task planning.

There has been considerable interest in the task planning model that Senior Design Center Director Margaret Heil initially developed for the CS capstone [6], [7], [8], [9], [10]. However, while there exists a good deal of research on task planning itself, until now there have been no assessments of task planning designed to gauge what our students take away from the activity. To address this gap in the literature, I developed two sets of questions around the task planning experience: a pre-survey and post-survey. The data collected as part of this study received research exempt status (eIRB #27454) since it does not reveal identifying information around students' gender identity or ethnicity — an important consideration in smaller courses like Senior Design — nor does it use FERPA-protected data such as course grades.

The pre-task planning survey (Pre-TPS) gauges learners' perceptions of course activities and team cohesiveness before they participate in the project management activity. The seven questions on the pre-survey are a mix of true/false, multiple choice, and short response. The follow-up post-task planning survey (Post-TPS) looks at team approaches to work division and project scoping after they have completed the activity. Students' experience is assessed through seven follow-up questions — two isomorphic to the Pre-TPS, with the remaining five questions asking students to reflect on post-tasking outcomes. Each of these surveys is driven by two overarching research questions:

RQ 1: Which activities within task planning did teams find most effective to their learning process?

RQ2: Which task planning activities did teams perceive as less effective to their learning process?

The next section of the paper describes the steps taken to develop the Pre-TPS and Post-TPS assessments, from subject selection and question development to survey deployment. It also considers challenges along the way and how the Pre- and Post-TPS may continue to evolve now that a course baseline has been established.

3.1 Subject Selection

Study subjects consisted of students enrolled in Sections 1 and 5 of the NC State CS capstone during the Fall 2024 semester. There were five sections of the course offered during that semester, with Section 1 meeting for two hours twice a week on Monday and Wednesday mornings and Section 5 meeting for two hours twice a week on Tuesday and Thursday afternoons. Senior Design staff attempted to schedule the majority of task planning sessions during class time so as not to inconvenience students. With each session lasting one hour, we can schedule four task planning sessions during class time each week, though we also offer sessions outside of class time for teams who prefer to meet then. All team members must be present during the activity; missing the session is equivalent to missing half a class period.

Students sign up for a time that works for all members of their team using the appointment feature of the course Google calendar. Because most teams are working in the Senior Design lab, task planning takes place in either the SDC annex (a meeting room across from the lab) or in a conference rooms elsewhere in the building. In order to give each team a quality experience, we endeavor to spread out task planning sessions, with no more than four sessions per day. With over 30 student teams and two Senior Design faculty conducting the hour-long task planning sessions, we managed to task plan with every team over the course of a week and a half.

As part of the IRB protocol, I informed the students who had signed up for my task planning sessions of the study's parameters and the fact that they could opt out without penalty. Students were also assured that their identities would remain anonymous. They would not receive any incentive for completing the surveys, nor would they be penalized for opting out. I was also transparent about how the dataset would be used, with an aim of studying our teaching methods so that students in the CS capstone continue to have an enriching experience that benefits them whether they pursue a career in industry or graduate school.

While students could opt out without penalty, everyone who was present in my tasking sessions ultimately decided to participate. I did have one student who had to leave early to so they could be on-time for an exam, so they only took the Pre-TPS, and, in two separate teams, one student was absent. In total, I collected **68/70 Pre-TPS** and **67/70 Post-TPS** handouts between the dates of Wednesday, September 4 through Friday, September 13, 2024.

3.2 Survey Development and Deployment

Students filled out pre- and post-tasking surveys consisting of a combination of multiple choice questions, Likert scale questions, and short, written responses. I made sure not to include any potentially identifying questions in the survey design — nothing related to demographic data, other courses students had taken, or anything else that could potentially identify an individual. Given that our class sizes are relatively small for our department, with a maximum enrollment of 35 students in each section of Senior Design during the Fall 2024 semester, this concern was not unfounded. I opted for diagnostic questions focused on individual and team goals [12]. I also did not want to go over the hour allotted for each task planning session or to unduly influence students' perception of the activity, so both surveys took no more than five minutes to complete. With this in mind, I designed seven questions for both surveys, two of which offer isometric measurements, with the other five being unique to the Pre- and Post-Tasking experience.

Prior to the start of the task planning activity, I passed out the IRB Exempt Consent form, asking students to please read through it along with me as I read aloud (to accommodate both aural and visual learners). Then, I asked for verbal acknowledgment and consent that they understood what they would be filling out.

After obtaining participants' consent, I passed around the Pre-TPS handout, which began with a bit of background to contextualize the study:

> Thank you for taking the time to answer the questions in this survey! They are part of a study meant to enhance the Task Planning experience for you and other students in Senior Design.
>
> As part of the course, teams participate in a team management activity known as Task Planning, but we currently do not have a way to take a snapshot of student impressions before or after the activity. That's where you come in! The information gathered here will be used to enhance our course's learning goals. This survey is completely **anonymous**, and you have the option to **opt out at any time.**

Figure 1: Pre- and Post-Task Planning Background Information

The wording shown in Figure 1 appeared on both the Pre- and Post-TPS handouts, maintaining consistency across the surveys.

Students were then presented with brief directions, which noted that they should "Please read each question and write a short response or circle the answer which you feel is the best fit. This survey should take no more than a few minutes. Thank you."

I then turned to the whiteboard to prepare it for task planning in order to give the students privacy to take the survey. When they were finished, they were asked to place the survey handout in a manilla envelope, which I only had the section number listed on. I did not know the order in which students placed their surveys in the envelope, and there was no identifying information included in the questions in order to preserve anonymity.

The Pre-TPS, shown in Figure 2 below, asked students the following questions:

1) Briefly describe what you think Task Planning is in Senior Design.

2) What are you concerned about in your project prior to Task Planning? Please list or describe.

3) Pertaining to **requirements**, please circle the letter that best fits your current team progress.

a) We have not yet started to define our requirements.
b) We are partway through defining our requirements.
c) We are finished drafting our requirements.

4) What are your goals for yourself on your team this semester? Please circle all that apply.
a) Learning new programming languages, tools, and technologies
b) Becoming a better communicator
c) Collaborating on a task or challenge as part of a team
d) Taking on leadership roles / serving as project lead
e) Other: _____

5) I am a bit unsure about what tasks I need to complete. Please circle one: **True** or **False**

6) My team has already begun working on our IPR. Please circle one: **Yes** or **No**

7) On a scale of 1 to 5, with 1 feeling very unprepared, 3 feeling sort of prepared, and 5 feeling extremely prepared, how prepared do you feel for your team project ***prior*** to the upcoming Task Planning session? Please circle your response: **1 2 3 4 5**

Figure 2: Pre-Task Planning Questions

The Post-TPS, shown in Figure 3 below, asked students these follow-up questions:

1) Have you ever Task Planned for a project before today? Please circle one: **Yes** or **No**

2) What are you concerned about in your project after Task Planning?

3) What parts(s) of Task Planning were most beneficial to your learning process? Which were less beneficial? Please describe.

4) What changes / revisions will you make to your individual or team work process going forward as a result of Task Planning? Please list or describe below.

5) I am still a bit unsure about what tasks I need to complete. Please circle one: **True** or **False**

6) In the next few weeks, I would like to … (circle all that apply)
a) Take on more of a leadership role
b) Shine in more of a background / supporting team role
c) Repeat this activity with my team members
d) Revisit _____ in our project (please fill in the blank)

7) On a scale of 1 to 5, with 1 being very unprepared and 5 being extremely prepared, how prepared do you feel for your team project ***after*** Task Planning? Please circle your response: **1 2 3 4 5**

Figure 3: Pre-Task Planning Questions

4. Results

My research involved analyzing just under 70 pre- and post-task planning surveys completed by students in two sections of Senior Design during the Fall 2024 semester. Open coding was combined with qualitative analysis to interpret survey responses. In order identify patterns, I cite specific student responses and then interpret them thematically.

This section of the paper is divided into four subsections. In the first, I apply open coding to student responses in the data gathered from the Pre-TPS in Section 1 of the course. In the second subsection, I apply open coding to student responses in the data gathered from Section 5's Pre-TPS. In the third subsection, I use open coding to explore Section 1's Post-TPS. And, in the fourth subsection, I apply open coding to explore the Post-TPS for Section 5. In each subsection, I also explore themes emerging from the datasets [13].

4.1 Qualitative Analysis of Findings: Themes from the Section 1 Pre-TPS

The first theme to emerge from the Section 1 Pre-TPS was how task planning helped teams to better **understand and define the scope of their projects**. Student respondents appreciated the idea of approaching the project as a series of more manageable tasks. For instance, one student wrote that they found it helpful to "break down requirements of the project into small tangible action items" while another commented on how helpful it was "planning out tasks and deadlines of when they should be completed." Respondents also noted the importance of assigning tasks to team members. It was also crucial for students to come away from the session with a working timeline, a clear plan for their first iteration, and a set of collaboratively-defined tasks [14].

A second major theme to emerge from the Section 1 Pre-TPS was a **concern about completing project deliverables in time**. Students seemed uncertain whether they could get to all their sponsor- and team-defined requirements by the end of the semester, with specific comments centered around different work styles among team members, issues with getting the development environment to work on their machines (i.e. "setup issues on my laptop"), and coordinating tasks among individuals or sub-teams. Of specific concern was learning new tools and technologies in a short period of time and working on team-defined sprints or iterations. According to the literature on project-based post-secondary courses, this learning curve is something many students struggle with, so it is important to foreground guided activities such as task planning early in the semester as student teams are still learning how to work together [15].

Task planning also inspired student teams to define their goals around communication and individual and peer responsibilities. Rather than making broad plans, teams sought to create **outcome-oriented goals**, keeping their end users in mind when envisioning system architecture and choosing technologies for their frontend, backend, and database.

A final theme that emerged in the Section 1 Pre-TPS was the importance of **defining requirements**. Whether a team chose to express requirements traditionally, via use cases, or user stories, students noted how they wanted to nail down requirements before moving forward with their first iteration. By considering which features they wanted to tackle first, teams that had yet to fully flesh out their requirements made progress during the tasking exercise, in some cases by creating wireframes. Other teams that had already drafted a working set of requirements were able prioritize features for their first iteration [16]. Teams felt that their progress was at varying stages with this milestone.

4.2 Qualitative Analysis of Findings: Themes from the Section 5 Pre-TPS

Section 5's Pre-TPS responses were analogous to Section 1's in some ways yet also demonstrated some distinct differences. The first major theme to emerge when I open coded the Pre-TPS for Section 5 was **task identification**. Keeping things manageable in each iteration seemed to be how teams preferred to approach to this, with common action phrases including "breaking down," "planning," "delegating," and "creating." Given that most projects in this section were games projects as opposed to the traditional software engineering projects in Section 1, design was a common thread. Conversely, there were also some concerns related to task identification, with students raising questions about time management, scope creep, and resource access when it came to game engines such as Unity [17].

A second major theme to emerge from open coding the Section 5 Pre-TPS was **communication and collaboration**. As I noted in the introduction of this paper, these are sought-after skills among project managers in the tech sector. Teamwork and decision-making were areas students cited, with some noting that they would need to delegate tasks and hold themselves and their teammates to "being punctual" when it came to team meetings (echoing their ground rules). Other students noted that it was important to make collective rather than individual decisions, gesturing toward the cooperative teaming inherent in the Senior Design experience [18].

Another theme that emerged from the Section 5 pre-tasking surveys was **uncertainties around team preparedness**. Students expressed doubt in their ability to quickly grasp new tools and technologies, with words such as "unclear," "unsure," or "uncertain" cropping up more frequently than teams that felt more confident (i.e. "no major concerns at the moment"). This sense of trepidation is not uncommon in upper level, project-based CS courses, as the research suggests [19], [20]. To mitigate these uncertainties, respondents emphasized the need to set deadlines and work from a calendar-driven approach.

Learning new skills was rated as both a pro *and* con, with some students framing knowledge acquisition positively (i.e. excitement at "learning new tools") even as others were more reluctant to be part of a team, perhaps owing to less-than-successful experiences in previous courses. "Finding time to do team things," "not having enough meeting time," and "ensuring everyone [makes] fair contributions" were a few of the concern-tinged comments, with some participants worried about whether they brought a strong skill set to the table and others wondering if their team members were as proficient as they said they were. Group schedule coordination and matching team members' talents to specific tasks were ways students thought they could preemptively address these issues [21].

Finally, the Section 5 Pre-TPS indicated an openness to viewing the task planning activity as an **opportunity for goal setting**. Students wanted to have autonomy in articulating their objectives, defining team milestones, and breaking down large tasks into smaller pieces, giving themselves greater ownership in their projects. At the same time, it was equally important for teams to have the teaching staff model professional communication and mentor them in technical areas.

4.3 Qualitative Analysis of Findings: Themes from the Section 1 Post-TPS

Section 1's Post-TPS were completed during the final five minutes of each team task planning session, and, as with the Pre-TPS, were completely anonymous, with no demographic data or

questions that could easily identify participants. As with the Pre-TPS, I applied open coding to the surveys, making two passes over the data to ensure accuracy and follow best practices [22].

For the question which asked student respondents to reflect on the benefits of task planning, three themes emerged during the open coding process: the importance of **visualization as a path to organization**, **task breakdown/delegation**, and **goal setting**. A number of students highlighted the value of making a detailed timeline. Teams hoped to break down complex ideas into smaller, more digestible pieces [23]. Task delegation and the creation of sub-teams were noted as essential for making projects seem more manageable, while iterative planning and regular feedback (between team members, teams and sponsors, and teams and the teaching staff) were vital to students' sense of progress [24].

Below is a breakdown of the open coding for the question aligning with my first RQ — which task planning activities students in Section 1 found *most beneficial* to their learning process:

- Whiteboarding: **4 students** mentioned whiteboarding or visual aids for task mapping and project planning.
- Timeline/Calendar: **9 students** indicated that creating a timeline or a calendar was highly beneficial for both short-term planning and setting long-term goals.
- High-Level Design: **8 students** found diagramming high-level system architecture, either through a more traditional SE diagram or an AGE diagram, was beneficial in helping visualize their project.
- Task Assignment: **10 students** appreciated the clear division of tasks among team members, which gave them a plan for who was responsible for what.

Other students noted that dividing into **sub-teams** for frontend and backend helped make the project feel more manageable, while tasking also helped students identify potential issues earlier rather than midway into the semester.

The data also revealed some flaws in task planning. While exploring design was helpful for some students, several learners expressed frustration with the design-focused portion of our discussion, particularly for teams that had already had to do this for their sponsors. Others felt overwhelmed by the level of detail when filling out the calendar for the first 4–6 weeks of the semester. These gaps demonstrate the need to tailor task planning sessions to meet teams where they are [25].

Below are specifics from the open coding of which activities were *less beneficial* to students' learning process:

- High-Level Design Discussions: **4 students** said that discussing the high-level design felt like they were retreading things they already had covered.
- Overwhelm vs. Redundancy in Planning: **3 students** found the level of detail we went into during tasking to be overwhelming, while **5 participants** with continuing projects found it to be repetitive.

A few students also commented how discussions about long-term goals (i.e. risks, testing) felt irrelevant when they were just beginning their first iteration. Looking ahead, respondents indicated a desire for **more structured planning**, better **task management**, and **more team role**

exploration. There was also a strong emphasis on communication around tasks, such as defining sub-team roles more explicitly and ensuring that all team members were on the same page when it came to project outcomes.

Finally, team confidence and preparedness were mostly high, with many students feeling that the task planning exercise helped them feel more **prepared to dive into the project**. Many respondents expressed an interest in taking on more of a **leadership role** after tasking. Additionally, a notable portion of student teams wanted to **revisit project requirements** as the semester progressed, perhaps through repeating this whiteboarding exercise, refining their goals based on evolving project needs [26].

For the questions related to team preparedness, open coding revealed the following themes:

- A majority of respondents (28 out of 32) rated their preparedness for the project as either 4 or 5, suggesting that the task planning exercise did a lot to increase their overall sense of confidence.
- A few (6 students) gave lower ratings (1–3), possibly indicating a need for further refinement of tasking for teams working on continuing projects.

For the question considering leadership roles and team group dynamics, Section 1 responses showed that

- **13 respondents** expressed an interest in taking on a more active leadership role, showing a desire for increased responsibility in the project's execution.
- **19 students** wanted to refine features as they moved through the project.
- **4 survey respondents** specifically mentioned revisiting requirements.

Key takeaways from the Section 1 Post-TPS include a strong emphasis on visualizing and organizing tasks through whiteboarding, continued timeline planning (using tools like Gantt charts, GitHub issues, or Kanban boards), and task breakdown to help team members manage their responsibilities. Clear task delegation, with a focus on defining roles and dividing the workload among individuals, was also important to students [27]. Overall, there was a clearer sense of team confidence and trust, with most respondents feeling more optimistic about the semester ahead after task planning.

4.4 Qualitative Analysis of Findings: Themes from the Section 5 Post-TPS

Section 5's Post-TPS were completed during the final five minutes of each task planning session, and, as with the Section 1 Post-TPS, were completely anonymous, with no demographic information or questions that could easily identify participants. As in Section 1, there are some students in Section 5 who identify as belonging to very specific genders or ethnicities, and, as such, all responses are anonymized so as not to identify these individuals. Again, I applied open coding to all the surveys, making two passes over the data to ensure accuracy [28].

Students in Section 5 found the **creation of a clear timeline**, **establishing deadlines**, and planning out their **first iteration** to be most beneficial to their learning, these task planning activities giving them a big picture view of their project. Additionally, outlining and delegating specific parts of the project provided clarity for who was responsible for each task and the sequence of work to be done.

Respondents particularly valued the breakdown of larger tasks into more manageable sub-tasks, which helped to better define the project scope for them. Furthermore, discussions around high-level design, and, in some cases, low-level design, were appreciated as they clarified the project structure and how its individual components would interact. Tasking was also beneficial as a team-building exercise, given that team formation in our capstone took place only a few weeks prior and was based on student feedback rather than a randomized team-forming algorithm [29].

Open coding for the question of which task planning activities Section 5 students found *most effective* for their learning process revealed the following:

- Creating a clear timeline: **9 students** mentioned defining deadlines and working through an iteration- or sprint-driven timeline to visualize what tasks needed to be completed when.
- Task delegation: **12 respondents** noted how outlining future tasks per the course calendar was central to their process.
- Design: **9 students** found it beneficial to explore high-level design in relation to their iterative methodology. This helped them understand the structure of the project and how individual components would work together.

While many students appreciated visualizing deliverables in a calendar-driven way, some found high-level and low-level design discussions to be less than helpful. A few teams felt that thinking about high-level design was **redundant**, especially if they were working on a continuing project. Moreover, **discussing risks and testing was seen as premature** or, in some cases, superfluous for teams whose sponsors had provided extensive guidelines around testing. Yet, as the literature suggests, even so-called 'negative' survey responses are useful because they show that teams feel psychologically 'safe' enough to express conflicting opinions [30].

Open coding of which activities were *less helpful* to their learning process revealed the following for Section 5 students:

- High-level design: **5 students** observed that diagramming was less helpful for them, especially those were working with a pre-existing design (i.e. continuing projects). Low-level design brainstorming also seemed unnecessary for respondents who felt they already had a clear grasp of their project.
- Risks: **3 students** felt this discussion to be tangential to their work since their projects had none or that any potential risks had already been covered in sponsor-provided documents (e.g., intro packet, prior discussions). Conversely, three other students noted that this discussion *was* helpful for them.
- Requirements definition: **7 students** did not appreciate this part of task planning, as they had either already refined their requirements or, for continuing projects, respondents felt that the requirements had already been defined by the past semester's student team.

The task planning exercise did, however, encourage teams to revisit their approaches to different parts of the project — even if they felt parts of the activity were less than helpful to them personally. A common thread was the need to practice more **active communication** when assigning tasks and creating timelines [31]. Another area of improvement involved the inclusion

of design **diagrams and visual aids**, particularly for complex project elements. This was also seen as beneficial to share with less-technical sponsors. Finally, several student respondents acknowledged the importance of **testing**, with a strong desire to engage in more thorough discussions about certain types of testing (i.e. usability testing, creating scripts for playtesting).

A majority of respondents (94%, or 31 out of 33) expressed high confidence that task planning would lead to more productive teamwork moving forward, indicating that the process played a crucial role in organizing their thoughts [32]. Several students expressed a desire to take on more leadership responsibilities in the upcoming phases of the project, while others preferred to assume more a supporting role.

Ultimately, for Section 5 students, the benefits of task planning were primarily seen in the creation of a clear timeline, effective task delegation, and clarifying deadlines and deliverables. However, some activities, such as sketching out a high-level design diagram, were considered less effective to their learning process. Moving forward, students planned to improve communication, focus more on iterations, and develop detailed schedules, with a clear majority of students noting that task planning would boost their team productivity at this early stage of the semester [33].

5. Comparison of Pre- and Post-TPS for Sections 1 and 5 of Senior Design

In the following sections, I compare common themes in the Pre-TPS for Sections 1 and 5 and the Post-TPS for Sections 1 and 5, touching on the broader trends that emerged from the surveys. Finally, in section 5.3 I contextualize the survey findings around the two research questions driving this project — which task planning activities did teams find *most effective* and *less effective* to their learning process — placing the patterns within a broader context of teaming, group dynamics, and project management in CS.

5.1 Common Themes between Section 1 and Section 5 Pre-TPS

In both sections, a central theme in the Pre-TPS was students' desire to break down larger pieces of the project into more **manageable tasks** and to ensure those tasks were **evenly divided** among team members. This approach not only clarified the scope of the project but also ensured a sense of fairness as team members collaboratively defined responsibilities, emphasizing how teams appreciated having agency in scaffolding their projects [34]. In both survey sets, the act of organizing tasks, often with a focus on role assignment and setting deadlines, was repeatedly cited as a strategy for keeping the project on track and for teams taking ownership of their process.

Concerns about **how to approach difficult tasks and project requirements** emerged as another prominent theme in both sections. Prior to the task planning, students expressed worries about not having enough information to properly estimate task duration or understand the full scope of their projects. Many teams were unsure about what exactly needed to be done and how to handle unforeseen challenges, reflecting a general sense of anxiety. The fact that students felt at ease enough to express these feelings demonstrates how task planning also engendered a sense of psychological safety within the teaming process [35]. After task planning, these concerns did not magically vanish, with a few respondents still expressing unease about requirements, unfinalized designs, and the difficulty in accurately estimating how much time certain tasks might take, particularly those related to learning new tools and technologies. This indicates that while task

planning may provide a welcome sense of structure, uncertainty surrounding certain project deliverables remains a consistent challenge the teaching team will need to address going forward.

Both sections also emphasized how crucial **task allocation and prioritization** was. Prior to task planning, students recognized the value of breaking projects down into smaller tasks and distributing them based on team members' strengths. Assigning tasks based on peer experience and availability was seen as key to preventing implementation delays [36]. Repeated references to work allocation in both sections indicate that clear task delegation is essential not only for effective project management, but also for maximizing team productivity and minimizing students' trepidation about their projects.

Effective communication and collaboration were also highlighted as essential elements of successful project management in both sets of responses [37]. Before task planning, students understood that the importance of good communication, while afterward, they reflected a shared sense that the success of a project was not solely dependent on individual contributions but on the collective effort of the whole team.

5.2 Common Themes between Section 1 sand Section 5 Post-TPS

A prominent theme that emerged from the Section 1 and 5 Post-TPS was the importance of having a **clear vision of project features**. Prior to task planning, many students mentioned grappling with scope creep. Task planning helped them to better visualize the structure of the project by mapping out tasks, timelines, and dependencies. Visuals such as design diagrams allowed teams to imagine their project architecture. Writing out weekly schedules and iteration roadmaps on the whiteboard were equally instrumental in making the project feel more manageable, helping to foster a shared sense of purpose among team members [39].

Both groups of students stated they had a **clearer understanding of their project *after* task planning** than they did going into the session. A significant number of teams appreciated the ability to break down the work into sub-teams, with others emphasizing the importance of improving team coordination through pair programming, using Slack or Discord for communication, and composing documents such as a requirements overview as a team [40].

Thinking about their projects in **smaller, more manageable pieces** emerged as another common theme across the sections. In their Post-TPS responses, students appreciated things like how "we broke down the project into features, making the work seem more achievable." This also allowed for a more structured approach to assigning tasks, with teams able to distribute work based on individual strengths and around team members' availability [41]. By clearly sketching out their design and delineating tasks, teams were able to organize work more effectively, thus reducing confusion and increasing their sense of focus [42].

A significant concern that students expressed in the Post-TPS data was how **difficult it would be to complete their project in just one semester** [43]. Prior to task planning, many student respondents were anxious about tasks taking longer than expected, which could negatively impact their ability to meet either sponsor- or team-defined deadlines. These concerns were mirrored in the Post-TPS responses, with teams still worried about tight deadlines and what would happen if access to things like repositories was delayed. However, the task planning process itself appeared to dissipate some of this worry, as teams felt more confident about their

ability to manage their time effectively [44]. While concerns about scope creep remained, the structured approach provided by task planning gave teams a clearer sense of how to estimate how long a task would take and what research and resources would be necessary, potentially alleviating anxiety around project completion [45].

The Post-TPS data highlight several benefits to task planning, including a clearer understanding of projects, a toolbox for breaking down tasks into manageable iterations, and a way to use visuals to improve team communication. These elements facilitated a more organized and strategic approach to each project. However, Section 1 and 5 students also identified things that were less beneficial to their learning process, such as the redundancy of discussing requirements or design for continuing project teams. Despite these challenges, the overall sentiment expressed by students was that task planning would positively impact team productivity going forward.

5.3 Summary of Research Question 1 and 2 Findings

Two research questions have driven this work on student-centered responses to task planning. The first question is **which activities within task planning did teams find *most effective* to their learning process**? Students in both Section 1 and Section 5 of the CS capstone identified several activities that they felt were highly effective. The first activity was **whiteboarding**, which helped students map out tasks more clearly. Additionally, **creating a timeline or calendar** was widely referenced for both short-term and long-term strategizing, allowing students to define deadlines around their iterations or sprints.

Another foundational activity was **high-level design**, where students found diagramming the system architecture (through traditional SE or AGE diagrams) valuable for understanding the project's structure and interrelationships between components. **Task assignments** also played a critical role, with students noting the importance of clear delegation of work among team members, ensuring that everyone understood their responsibilities. Moreover, dividing the project into sub-teams (such as frontend and backend or feature A and feature B) helped make the overall workload seem more manageable. Lastly, task planning facilitated early identification of **potential pain points**, enabling teams to begin to talk about challenges before they became larger problems later in the semester.

The second research question driving this qualitative analysis is w**hich task planning activities did teams perceive as *less effective* to their learning process?** Some activities were less effective for students, particularly those working on continuing projects. **High-level design discussions** were seen as redundant for those with pre-existing designs or clear project concepts. These students felt that resketching design elements they had already addressed was not productive. Additionally, mapping out an iteration by features, who was doing what, and estimating hours was described as **overwhelming** for some students, while teams with continuing projects found the discussion to be **repetitive**.

Specific discussions around long-term goals like **testing** also felt irrelevant to students just beginning their first iteration, as they were focused on more immediate concerns. Moreover, defining **requirements** was not useful for students who had already refined their requirements or for those working on a continuing project. While some students found discussing **risks** to be helpful, others thought that was tangential to their current work (i.e. risks had already been addressed by sponsors or there were no relevant risks to completing their work in one semester).

These responses suggest that we need to refocus task planning sessions for teams with continuing Senior Design projects.

6. Conclusion — Suggestions for Improving and Expanding the Surveys

The final section of this paper examines the Pre- and Post-TPS as a baseline for future work, considers the limitations of these surveys, and suggests how they could be implemented across all sections of Senior Design. Survey data might also be useful for ABET or similar accreditation efforts as well as a model for other Senior Design capstone courses in the College of Engineering and beyond.

Suggestion 1: Clarify Questions in the Pre-TPS

Some questions contained unclear phrasing that could confuse survey-takers. Going forward, we aim to redesign the surveys to **be more specific and clearly worded** to avoid confusion and improve consistency in student responses. For instance, where one question currently reads "What are you concerned about in your project prior to Task Planning?" a revised version of the question might ask students: "What are your specific concerns about your project's scope, timeline, and task breakdown before starting our task planning session?" These questions might also jumpstart interesting conversations with teams.

Suggestion 2: Ask Follow-Up Questions for Likert-Scale Questions

While the surveys include several multiple-choice questions, there was a lack of open-ended follow-ups to capture richer qualitative data, especially for more personal concerns. Questions that require a quantitative assessment (e.g., "On a scale of 1 to 5, how prepared do you feel about your team project prior to the upcoming Task Planning session?") could be followed by a reflective question asking students to describe specific challenges around preparedness.

Suggestion 3: Reword Multiple-Choice Questions

In some multiple-choice questions, the options might not fully capture the range of students' experiences. Where I currently ask students: "Pertaining to requirements, please circle the letter that best fits your current team progress: a) We have not yet started to define our requirements. b) We are partway through defining our requirements. c) We have finished drafting our requirements," an improved version of the question might ask: "How well-defined are your project requirements at this point in the semester? (Choose one): a) Not yet started b) In the process of defining c) Requirements are mostly defined, but some ambiguity remains d) Fully defined and clear."

Suggestion 4: Move Away from True/False Questions

A significant number of student respondents expressed uncertainty about the tasks they needed to complete, as evidenced by responses to "True/False" questions. However, True/False questions fail to fully capture this uncertainty or provide insights into potential solutions. We plan to revise the question to focus on particular aspects of the project causing. For instance, an improved version of the current question might read: "Are there any specific tasks or aspects of the project

that you're unsure about? If so, which ones and what additional information do you need?" This approach would offer more insights than T/F responses can.

Suggestion 5: Refine the Feedback Loop for Task Planning Sessions

While tasking was an effective project management activity, there was not much follow-up or callbacks to the exercise as the semester went on. This discussion could begin in the Post-TPS by asking students to reflect on their goals/outcomes from task planning. By understanding team-specific needs, instructors can ensure that the focus is directed toward those areas. For example, the current question — "Briefly describe what you think Task Planning is and/or what you hope to get out of our Task Planning session today" — can be refined to read "What specific outcomes would make the Task Planning session most useful for your team? Please describe any aspects of planning or team coordination you need the most support with." This revised question could allow for better-targeted support throughout the remainder of the semester. To improve the effectiveness and precision of task planning surveys in the future, we hope to revise the current questions and deploy them to all students in the capstone.

In conclusion, refining the survey questions to yield more specific, actionable insights around task comprehension, time management, and team coordination should provide a more detailed picture of team preparedness. Composing separate questions around team roles, managing deadlines, and team collaboration would also offer a clearer picture of areas where teams might require more support. This would help student respondents reflect more clearly on their future contributions within the task planning context. Including more Likert-scale questions for specific aspects of task planning could generate more quantitative data on what respondents found most and least helpful about the project management exercise. Finally, questions regarding revisions and improvements to team processes should be more specific and goal-oriented. By implementing these revisions in Spring 2025 and beyond, we hope to gather greater insights from Senior Design teams, facilitating targeted improvements in this management activity and enabling students to better coordinate and plan for the upcoming phases of their sponsor-mentored projects.

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