Evaluating the Effectiveness of Accountability Reporting Tools in an Engineering Capstone Course

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ABSTRACT

Preparing engineering students for the realities of a rapidly evolving profession remains a key challenge for educators. Capstone projects—culminating experiences in the final year of an engineering curriculum—are a widely used experiential tool that offers students exposure to multidisciplinary teamwork, professional accountability, and project-based learning. However, to truly align these experiences with industry standards, it is critical to incorporate clear metrics that measure student progress, teamwork effectiveness, and milestone achievements. Embedding such evaluation frameworks not only enhances accountability but also ensures continuous improvement and meaningful outcomes in the engineering education capstone curriculum.

This study evaluates the accountability reporting tools used in a design-build civil and construction engineering capstone course at The Citadel. The accountability reports were developed by instructors and used to assess team effectiveness, record individual accountability, and assess how well teams work to achieve their goals towards completing the design-build project. Five tools were used during the academic year: 1) Weekly Planning Meetings, 2) Weekly Timesheet Record, 3) Daily Task Record 4) Class Attendance Sheet, and 5) Milestone Tracker.

To investigate the effectiveness of the accountability reporting tools, a survey was presented to the students in the civil and construction engineering capstone course at the end of the 2025 academic year. In this survey, each tool was first evaluated individually and then evaluated in comparison to the other tools. Five-point Likert scales were used to assess individual tools (i.e., strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree) and to compare across tools (i.e., very effective, effective, moderately effective, slightly effective, and not effective).

Aggregated survey results from thirty-three (33) capstone course students showed that over 60% of respondents had a favorable view of the effectiveness of the accountability reporting tools. Comparative evaluation of the five tools indicated that the daily task record was most effective for individual accountability, individual time management, and completing personal tasks assigned by the team, with over 70% of respondents indicating that this strategy was moderately effective to very effective. Additionally, the weekly planning meetings were most effective for team accountability, team efficiency, and meeting team deadlines, with over 75% of students indicating that the tool was moderately effective to very effective.

This study highlights the value and effectiveness of team and individual accountability tools used in a civil and construction engineering capstone design-build course. Ultimately, with a strategic combination of the accountability tools presented, instructors can successfully simulate real-world environments to prepare graduating engineering students to function as effective and invaluable team members in a professional environment.

INTRODUCTION

Preparing engineering students for the realities of a rapidly evolving profession remains a key challenge for educators. This challenge can be attributed to reasons such as the fourth industrial revolution (industry 4.0) which is emblematic of the digital and technological age [1] and the gap between professional practice and engineering education perceptions of skills required by employers [2][3]. It is anticipated that the challenge to prepare students for the workforce will become even greater with the potential ubiquity of Artificial Intelligence (AI) applications on the verge of adoption in engineering and society at large [4].

Capstone projects—culminating experiences in the final year of an engineering curriculum—are a widely used experiential strategy that offers students exposure to multidisciplinary teamwork, professional accountability, and project-based learning. Providing students with an opportunity to gain experience and develop non-technical skills such as accountability is essential for a wholistic engineering education experience and is a skill desired by employers. To truly align the capstone experience with industry standards and expectations, it is critical to incorporate clear metrics that develop student accountability, measure student progress, teamwork effectiveness, and milestone achievements. Embedding such evaluation frameworks not only enhances accountability but also ensures continuous improvement and meaningful outcomes in the engineering education capstone curriculum.

The primary goal of this study was to evaluate the effectiveness of accountability reporting tools used in a senior design capstone course at The Citadel. The capstone course is a two-semester course providing a full academic year for students to apply acquired knowledge from previous fundamental design classes in the capstone designs. The course met twice a week, and student teams were comprised of 5 or 6 students. Five (5) different tools were utilized during the academic year: 1) Weekly Planning Meetings, 2) Weekly Timesheet Record, 3) Daily Task Record, 4) Class Attendance Sheet and 5) Milestone Tracker. Ultimately, the research aspiration was that with a strategic combination of the accountability tools presented and evaluated, instructors can successfully simulate real-world environments to prepare graduating engineering students to function as effective and invaluable team members in a professional environment.

LITERATURE REVIEW

The first step to being accountable is being present. In recent years, being present has taken other forms aside the physical, such as consistent interaction and active communication [5] as many colleges have adopted online or distance learning to provide flexibility and to extend reach [6] [7]. However, in a collaborative course such as a capstone design course it is important to value the physical and cognitive presence of students to succeed. Support for this concept is provided by Znidi et al, whose study investigated the effectiveness of instructional methods of face-to-face (F2F) and online capstone courses. In the study F2F groups reported higher levels of accountability

within the groups as a result of better collaboration and teamwork [8]. Research indicates that attendance records are still a widely used tool in team-oriented design courses. However, calling names tend to be time consuming in large classes and passing around a sign-in sheet could produce fraudulent sign-ins for absent students. In recent years educators have shifted to find more efficient and more automated ways to record attendance [9] – [11]. Automated forms of attendance used from the literature are ID scanners [9], card readers [10], and facial recognition attendance [11]. These automated methods of attendance reported operational gains, especially in time savings. However, from the studies each of these methods had their peculiar challenges. Although, it has not been shown from research that accountability is strongly correlated with attendance, studies have shown that attendance positively influences student performance [12][13] and is positively correlated to favorable peer reviews for collaborative project-based courses [14].

The use of peer evaluations is a customary practice in most team-oriented courses in higher education. One of the most widely used tools for peer evaluations is CATME (Comprehensive Assessment of Team Members Effectiveness). Since its deployment in 2005 [15], CATME has been used by over two thousand institutions in eighty-five countries [16]. Other forms of peer assessment, characterized by high frequency (daily or weekly) evaluations and multi-step evaluations have been implemented [17]-[19] in collaborative courses with similar goals to that of CATME. Which is to provide formative feedback to instructors about team climate and to develop accountability habits among team members. CATME was administered in the capstone course at the halfway point of each semester (fall and spring) to get a sense of team climate; however, it was not intended to be a tool for accountability as it was only used once each semester. For this reason, CATME was not included in this research as one of the accountability tools evaluated.

Over the years, there has been significant use of time-based and effort-based accountability tools in senior design courses. Time-based accountability can be in the form of time tracking using time sheets, cards, or logs [20]. Studies reported that time-based accountability was weakly correlated with actual student performance or grades [21]. However, this tool was effective in reducing social loafing while improving accountability, especially in large teams [20][22]. Other studies reported that the tool works best for early intervention in teams and is more effective when reviewed frequently and used in combination with other accountability and team assessment tools [18][20]-[22].

Additionally, contribution, effort, or activity reporting have been used in support of time-based accountability tools. In this strategy, students provide evidence of work done or to be done through records or activity logs [23]. A study by McGregor et al. utilized activity logs in a capstone course and found them effective in identifying disengaged students and workload imbalances early [19][23]. Other research reported the effectiveness of activity-based accountability tools in providing transparency in effort [20] and enhanced visibility of individual activity within teams [24]. All these benefits led to needed proactive corrective actions or interventions immediately rather than retrospectively through end of semester assessments [20] [24][25].

Another way to promote accountability within team projects is to have weekly meetings with reports or minutes. This tool is versatile as it can be used to measure many metrics such as team climate, participation, accountability, project decision tracking, and deadline tracking. Meetings have taken different forms according to literature. Faculty-led weekly progress meetings [18] have been utilized in some cases while others have used bi-weekly progress update meetings [26]. Authors have argued that the implementation of weekly meetings improve accountability among other professionalism metrics [18][26].

Similar to weekly meetings, another tool that serves multiple purposes is a milestone tracker. Although milestone tracking is primarily used to set clear expectations on deliverables and track project progress, its implementation provides a means to evaluate team and individual accountability as well [26]. Research found that a framework to track deliverables helped students pace their work and reported improved individual responsibly towards accomplishing milestones [22][25][26]. Trackers can take the form of rubrics, binary completion, or completion percentages [26]. Others have implemented progress tracking as part of weekly progress meetings, hence eliminating the need for a separate tool for milestone tracking [22][26].

This review of literature has highlighted the benefits of utilizing accountability tools in a senior design course or team-oriented design course. Some of these benefits include an early alert system for social loafing and struggling teams, instilling a sense of responsibility to teammates, project progress tracking, and improved faculty oversight. Although the reviewed tools were reported as being effective in promoting and evaluating team and individual accountability, it is safe to say that a strategic combination of some of these tools could lead to even greater gains in accountability and other professionalism metrics in design courses. From our review, the unique combination and scaffolding of multiple accountability tools used in this research has not been utilized or researched by others. Also, the comparative evaluations of tools conducted in this study present another area of research that was not evident from our review of literature. We believe our study addresses the research gaps identified in the literature review and is significantly contributing to the knowledge in the study of professional skills in academia.

METHODS

Accountability Reporting Tools

Students were required to use five accountability reporting tools throughout the academic year: 1) Class Attendance Sheet, 2) Weekly Planning Meetings, 3) Weekly Timesheet Record, 4) Milestone Tracker, and 5) Daily Task Record. Each tool was intended to assist students in making progress on their capstone project and to hold team members accountable to one another. Course instructors also used these tools to monitor students' progress throughout the course.

Accountability Tool #1: Weekly Planning Meetings

Student teams were required to meet weekly to discuss project progress and provide a summary of the meeting in the form of weekly planning meetings to be reviewed by the course instructors. Capstone projects include many design and planning components, with team members often working on different components concurrently. As such, these meeting minutes served as an accountability tool for team members to update one another on their progress and discuss their next steps. Students received several guidelines for the meetings and minutes, including a 15-minute minimum, a one-page report template, and a requirement that all team members attend. Students rotated through responsibilities for each meeting, with key roles including the meeting chair and minute recorder. The weekly meetings were implemented at the beginning of the fall semester and used until the middle of the spring semester. Instructors used these meeting minutes to evaluate team progress throughout the course. Figure 1 shows an example of recorded meeting minutes from a capstone team.

CAPSTONE - WEEKLY TEAM ACCOUNTABILITY MEETING REPORT

Team Name/Number: ABC Design & Construction Date: 9/19/2024
Location (Building/Room Number): Grimsley/117
Start Time: 14:03 End Time: 14:30

Team Members Present and Roles (List Names and Roles Below)
Team Member 1 (Chair), **Team Member 2** (Minutes Taker), **Team Member 3** (Contributor), **Team Member 4** (Contributor), **Team Member 5** (Contributor), **Team Member 6** (Contributor)

Meeting Minutes

10. Status of assigned tasks or action items from previous meeting (List Below)
    - Decided on the site that our eVTOL helipad will be located – **Finished (Site 1)**
    - The site evaluation matrix – nearly finished need paragraphs and picture - **Finished**
    - The 0's and 1's Scheduling – **working on it as we go**

11. What was discussed in this week's meeting (List Below)
    - CAD Template Drawings
    - Building Requirements for buildings on each site
    - Sketch a simple building design
    - Revit file for the buildings and hangars
    - Parking inside of the hangar
    - Travel Lanes and their dimensions (towing dimensions)
    - Early stages of developing our floor plan

12. What was achieved during the meeting? What are the action items for the next week? What team members are responsible for each action item (List Below)
    - Using hangar requirements to sketch different designs into each site. To get an idea of what could fit into it. Done either on CAD or Revit. Site 1 and site 2 (Team Member 4 and Team Member 6)
    - CAD file for site 2 for the hangar. (Team Member 3)

Figure 1: Example of recorded meeting minutes from a capstone team

Accountability Tool #2: Weekly Timesheet Record

Project teams were required to maintain weekly timesheet records, which tracked the amount of time each team member worked on the project each week. Each student was responsible for inputting their own time each week, starting at the beginning of the fall semester. This tool was implemented to help students manage their time effectively and to aid team members in holding each other accountable. This accountability tool mirrors timesheet recording used in the engineering industry, where professionals must be able to account for the hours that they have worked. Course instructors used the weekly timesheet records to monitor each student's contributions to their team's project. Figure 2 shows an example of timesheet records from a capstone team in the Spring 2025 semester.

Capstone Team and Individual Time Sheet Records

Team Name: **Engineeirng Design Group**

Team Number: 2

Due Date	Week No:	Team Members					Team Weekly Total (Hrs)
		Member 1	Member 2	Member 3	Member 4	Member 5	
1/21/2025	Week 1	1	6	3	1	0	**11**
1/28/2025	Week 2	0	2	3	1	1	**7**
2/4/2025	Week 3	2	4	3	1	2	**12**
2/11/2025	Week 4	1	4	10	2	2	**19**
2/18/2025	Week 5	3	3	6	2	7	**21**
2/25/2025	Week 6	4	6	6	2	6	**24**
3/4/2025	Week 7	2	8	3	4	4	**21**
3/11/2025	Week 8	2	10	4	6	2	**24**
3/18/2025	Spring Break	0	0	0	0	0	**0**
3/25/2025	Week 10	1	5	6	2	1	**15**
4/1/2025	Week 11	3	2	12	4	0	**21**
4/8/2025	Week 12	4	4	8	10	1	**27**
4/15/2025	Week 13	2	6	6	1	0	**15**
4/22/2025	Week 14	2	10	8	4	4	**28**
4/29/2025	Week 15	5	5	5	5	5	**25**
	(Hrs)	32	75	83	45	35	
						Team Total	270

Figure 2: Example of timesheet records utilized in the Spring 2025 semester

Accountability Tool #3: Daily Task Record

Instructors introduced an individual accountability tool in the spring semester—the individual daily task record. Students recorded progress in a shared worksheet, recording individual contributions while viewing overall team progress. Each team member was responsible for reporting the following for each class session: 1) current tasks—responsible, 2) current tasks—assisting, 3) future tasks—responsible, and 4) future tasks—assisting. For each task, students were required to provide a detailed description, personal deadlines, and information about collaborating with teammates. To maintain timeliness and accountability, spreadsheets were data and time

locked, not allowing entries after 11:59pm each class day. Instructors used the daily task records to monitor students' contributions and team progress. Figure 3 shows an example of a completed daily task record.

		Capstone Daily Task Record	
	Present Tasks Resposible For	**Present Assist or Review of Tasks**	**Future Tasks Responsible For**
Student Name	**What tasks were you responsible to start, continue or complete this class session?** ***Report the following 1. Detailed description of task 2. Personal Deadlines to complete these taks 3. Teammates you are working with if any***	**What tasks did you assist other teammates with or review this class session?** ***Report the following 1. Detailed description of task 2. Teammates you are working with if any***	**What task are you responsible to start, continue or complete before next class session?** ***Report the following 1. Detailed description of task 2. Personal Deadlines to complete these taks 3. Teammates you are working with if any***
Team Member 1	Comprehensive plans to ensure safety on-site and adherence to quality standards throughout the construction process 3/28/25	Discussed with Member 3 and Member 5 to take point on the assesment due 3/28	Finish saftey plans and update 0s and 1s
Team Member 2	Began working on updating the geotech portion of the report to reflect the new calculations that we have so far. Want to have updates done by (3/20/2025). Will have Member 3 review updates	Discussed with Member 4 about the changes within the geotech portion of the project.	Completely finalize and update the geotech portion of the report. Will complete when Member 1, Member 2, and I finish the geotech calculations portion.
Team Member 3	Calculation bearing pressure for column footing for 90% submission. Aim to have it done on (3/20/2025) Will have Member 5 and Member 1 review it.	Discussed with Member 5 on moving forward with the 90% structural portion.	Make progress with finding the bearing capacity and if I complete it early I will start on the Square Single Column Footing Design excel. Potentially update CAD issues addressed in 50%

Figure 3: Personal Daily Task Record example for a Capstone Team

Accountability Tool #4: Class Attendance Sheet

The purpose of the class attendance sheet was to track student attendance, particularly addressing waning attendance through different class formats. For instance, instructors noted varying levels of attendance in previous semesters for lectures, guest speakers, and working sessions. To particularly address attendance during team working sessions, students were required to sign in and out of the attendance sheet for each class session. The class attendance sheet was a record binder created for students to sign in and sign out during class periods. The binder had a sheet for each class period and was available to students at the beginning of class and towards the end of class. Figure 4 shows an example of the class attendance sheet being utilized. The attendance sheet was used throughout the fall semester. The class attendance sheet accounted for 2% of the overall course grade.

CAPSTONE SENIOR DESIGN CLASS ACCOUNTABILITY RECORD

DATE: 9/12/2024

NO:	NAME	TIME IN	SIGNATURE	TIME OUT	SIGNATURE	HRS SPENT
1	Student 1	1:30		3:30		2
2	Student 2	13:46		15:20		2
3	Student 3	13:20		3:20		2
4	Student 4	12:30				

Figure 4: Example of class attendance sheet utilized in the capstone course

Accountability Tool #5: Milestone Tracker

Capstone teams were responsible for tracking major project milestones using the 0s and 1s milestone tracker. Teams were required to record each major project milestone, the required completion date, and the actual completion date in a table. If the team met the required deadline, they recorded a "1" in the tracking column, otherwise they recorded a "0". At the end of each month, they calculated their team's performance, reporting the percentage of tasks completed on time. Teams reporting less than 85% of milestones completed at the end of a month were considered needing attention. Figure 5 and Figure 6 show an example table and graph respectively, of milestone tracking in the course. This tool was implemented at the beginning of the fall semester and used through the middle of the spring semester.

Item No.	Program Major Milestones	Date Required	Actual Date Completed	0 or 1	Monthly Performanc
5	1.3.1 Evaluate Beta Technologies Thunderdrome simulator	10/1/2024	10/1/2024	1	
7	1.3.3 Design CAE (simulator for Joby)	10/8/2024	10/5/2024	1	
8	1.3.4 Investigate L3Harris eVTOL simulator	10/24/2024	10/24/2024	1	
4	1.3 Consider evolution of Advanced Air Mobility allowing flexibility for simu	10/24/2024	10/24/2024	0	
18	4. Provide energy infrastructure for eVTOL operations	10/17/2024	10/10/2024	1	
9	1.4 Provide for adequate parking to be compliant with all local ordinances	10/24/2024	10/23/2024	1	
16	3.2 Locate and design adequate eVTOL parking	10/24/2024	10/23/2024	1	86%

Figure 5: Example table of the 0s and 1s milestone tracker

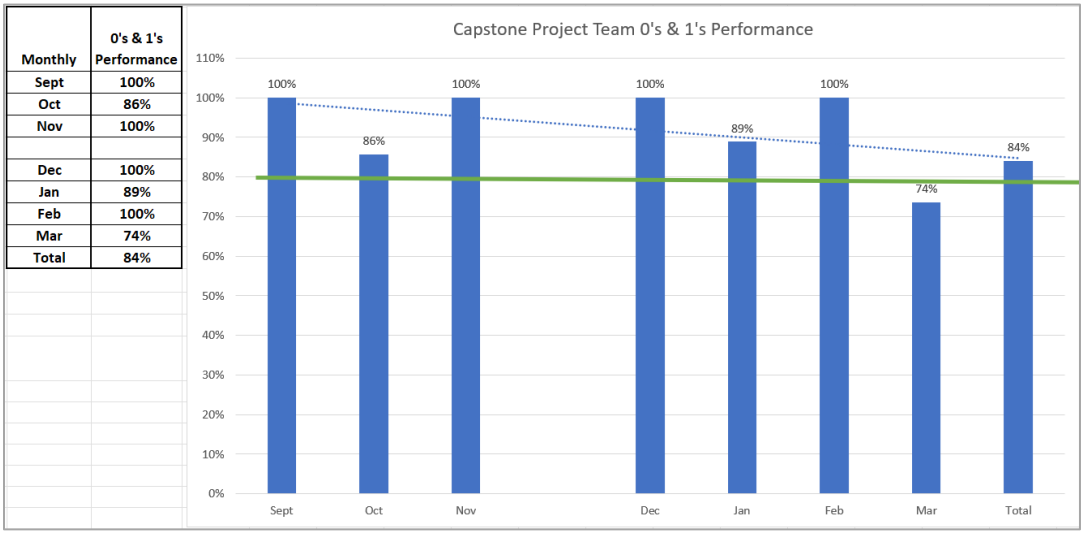

Figure 6: Example graph of the 0s and 1s milestone tracker

End-of-Course Student Surveys

To evaluate the effectiveness of the accountability tools, students completed surveys at the conclusion of the course during the last class period. The survey was developed by course instructors and administered using Microsoft Forms. Survey responses were not anonymous as the completion of the survey was one of the professionalism tasks to be graded for completion.

The survey included thirty-six (36) questions about the accountability tools used throughout the course. Students were asked to evaluate each tool individually before comparing all five tools to one another. There were thirty (30) questions on individual tools section and six (6) questions on the tool comparison section. Using a 5-point Likert Scale, students were asked to rate each tool's effectiveness in each of the following categories: i) individual accountability, ii) team accountability, iii) individual time management, iv) team time management, v) individual milestone completion, and vi) team milestone completion. Therefore, each tool had six (6) questions asked in the ordered categories previously mentioned. The questions asked in this section of the survey are by category as follows:

Q: 1, 7, 13, 19, 25 - Individual accountability
Q: 2, 8, 14, 20, 26 - Team accountability
Q: 3, 9, 15, 21, 27 - Individual time management
Q: 4, 10, 16, 22, 28 - Team time management
Q: 5, 11, 17, 23, 29 - Individual milestone completion
Q: 6, 12, 18, 24, 30 - Team milestone completion

In the comparative assessment, students were asked to rank the tools in order of effectiveness for each of those six categories as well. The survey format with example questions is shown in the sections that follow, and the complete survey is included in the Supplemental Materials.

Capstone Course Management Tools – Student Feedback Survey

This survey inquires about the effectiveness of the different course management tools used in the 2024-2025 CIVL/CONE Capstone Design Course at the Citadel in achieving individual and team outcomes for 1) Accountability 2) Time Management and 3) Achieving Goals. This survey will provide essential feedback on the tools below and will be invaluable input on the future utilization of these tools to manage the Capstone Design class.

Course management tools used

A) Team Weekly Planning Meeting with Minutes B) Team and Individual Time Sheet Record C) Personal Daily Task Record D) Class Sign In and Sign Out Sheet E) 0s and 1s Milestones Table

Description

Please rate your level of agreement with the following statements regarding each of the class management tools used in the capstone course.

Scale:
1 – Strongly Agree
2 – Agree
3 – Neither Agree Nor Disagree
4 – Disagree
5 – Strongly Disagree

Section A: Weekly Planning Meeting with Minutes (Introduced at beginning of fall semester)

Description: Teams were required to hold a planning meeting once a week for at least 15 minutes. Teams were required to keep a living document of meeting minutes to record what was discussed during their weekly planning meetings

1. The team weekly planning meeting with minutes helped me stay personally accountable *

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Please Select One	◯	◯	◯	◯	◯

Section B: Team and Individual Time Sheet Record (Introduced at beginning of fall semester)

Description: Individual team members were required to record their 'billable' hour of work on the project which created a weekly sum for individual and team hours. As well as overall hours spent working on the project.

8. The time keeping record helped our team stay accountable to each other *

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Please Select One	◯	◯	◯	◯	◯

Section C: Personal Daily Task Record (Introduced in middle of spring semester)

Description: Individual team members, during class periods were responsible to record tasks they are working on (or reviewing) and personal deadlines for completing those tasks

15. The personal daily task record helped me manage time effectively during this course *

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Please Select One	◯	◯	◯	◯	◯

Section D: Class Sign In and Sign Out Sheet (Introduced at beginning of fall semester)

Description: Individual team members were to sign-in on a sign-in sheet upon arrival to class (work) and sign-out when leaving class (work)

22. The sign-in/sign-out sheet helped our team manage time effectively during class *

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Please Select One	◯	◯	◯	◯	◯

Section E: 0s and 1s Milestones Table (Introduced at beginning of fall semester)

Description: Teams used the method of 0s and 1s, (0 for missed milestone deadlines and 1 for met milestone deadlines) to keep track of project progress

30. The 0s and 1s Milestones Table helped our team complete assigned tasks to meet project deadlines and milestones *

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Please Select One	◯	◯	◯	◯	◯

Section F: Comparative Evaluation of the Five Tools

Description: Please rank how effective you found each of the following tools in each category. Please **drag and drop the options** to rearrange the ranking order

31. **Promoting individual accountability**

Please **drag and drop the options** to rearrange the ranking order

Rank:
1 – Very Effective
2 – Effective
3 – Moderately Effective
4 – Slightly Effective
5 – Not Effective *

- Weekly Meeting with Minutes
- Time Sheets
- Personal Daily Task Record
- Sign In/Sing Out Sheet
- 0s and 1s Milestones Table

RESULTS AND DISCUSSION

Student Survey Results

Results indicated generally favorable perceptions across all tools, with variations in perceived effectiveness depending on the outcome category. Overall, thirty-three (33) capstone students completed the survey, representing 92% of the course's enrollment. Survey results were exported and aggregated by section with each section including six questions. The survey results are shown in Figure 7.

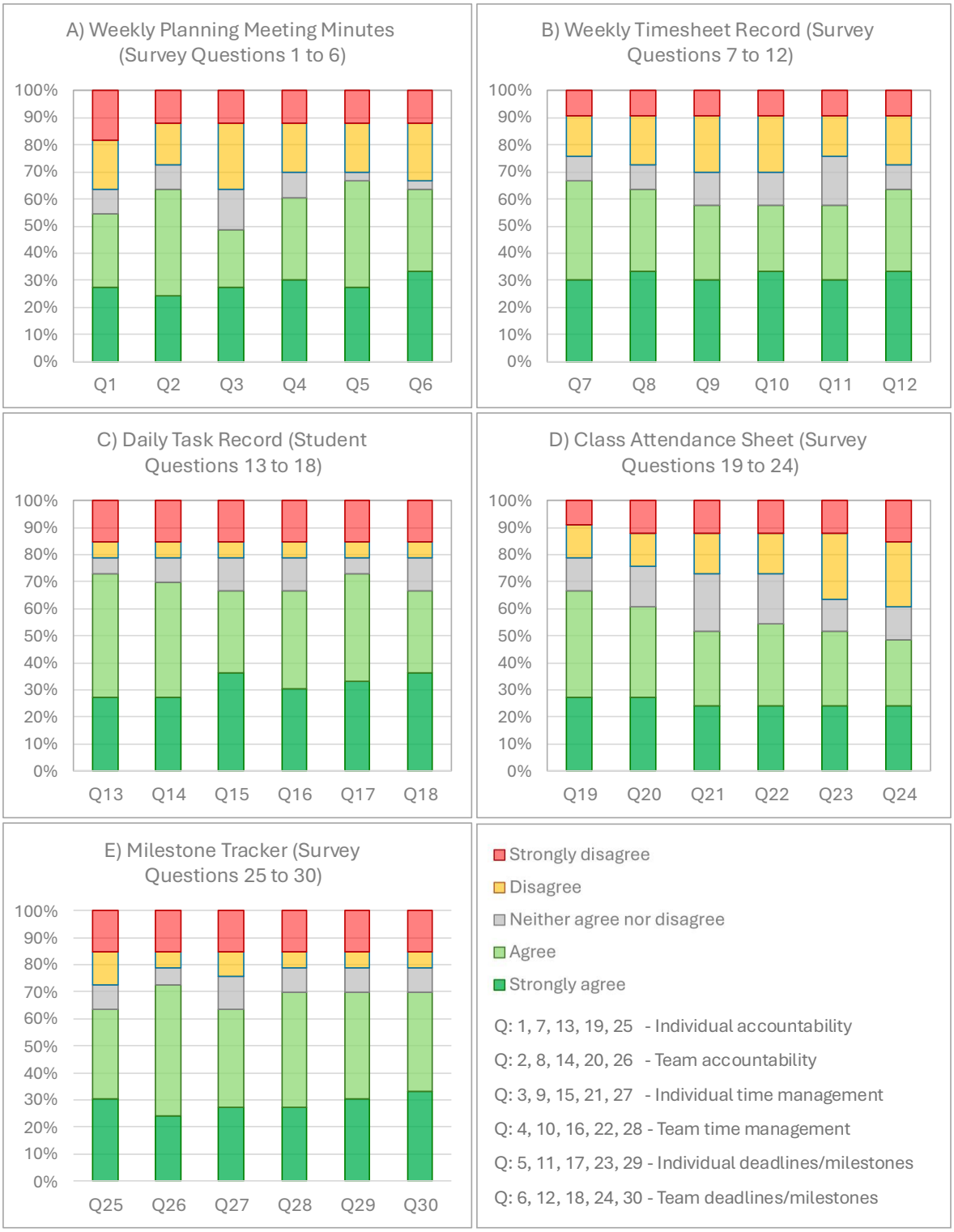

Figure 7: Response statistics to survey questions 1-30

Aggregated survey results from thirty-three capstone students showed that over 60% of respondents had a favorable view of the effectiveness of the accountability reporting tools. Comparative evaluation of the five tools indicated that the daily task record was most effective for

individual accountability, individual time management, and completing personal tasks assigned by the team. Over 70% of respondents indicated that the daily task record was moderately effective to very effective. Additionally, the weekly planning meetings were most effective for team accountability, team efficiency, and meeting team deadlines, with over 75% of students indicating that the tool was moderately effective to very effective.

Accountability Tool #1: Weekly Planning Meetings

Survey results show that students assessed the weekly planning meetings to be an effective tool with over 60% of students agreeing or strongly agreeing in four of the six survey questions. The tool was reported to be effective across all team categories but was seen to be most effective in task completion for individual team members.

It is commonplace to have students work outside of class time in most college classes to complete assigned homework, textbook readings, and research projects to mention a few. This is even more critical in a capstone design course. Capstone teams that effectively collaborate and utilize time outside of regularly scheduled class periods typically excel in the course and are recognized as higher preforming teams with significantly better final project deliverables. The inverse of this statement is also true. To help student teams manage time outside of class effectively, the weekly team meetings were instituted. This tool was introduced to capstone teams immediately after teams were formed at the beginning of Fall 2024. The tool was used until the middle of the Spring 2025 semester where all accountability reporting was switched to the daily task record yet to be discussed in this section.

The planning meetings provided a platform for teams to organize and efficiently direct their efforts to meet individual, team, and project milestones. Each meeting required a record of the meeting in the form of meeting minutes. Teams were required to keep a document where the topics discussed during each meeting were recorded.

Planning meetings are routine practices for many organizations. Engineering firms typically have weekly meetings at the beginning of the week or at the end of the week to plan for the next week. As the capstone course is a model of real-world engineering practice, the planning meetings were a vital part of student learning and were critical in helping teams organize the week. The general reception of the weekly planning meeting minutes was favorable by the students. The students realized that the tool was valuable to their success and continued to utilize this tool and completed them weekly. There were a few issues with the reporting at first. Recorded minutes were not detailed enough, and teams assumed that the reader of the minutes had insight into previous discussions. After a few cycles of critical and constructive feedback from professors, teams started producing more concise and more detailed meeting minutes that would be a good reference for later discussions.

The recorded meeting minutes gave the students a way to look back at previous discussions which could include due dates, task assignments, and meeting attendance. The meeting minutes also provided insight for the professors into how students were planning to accomplish weekly tasks.

Accountability Tool #2: Weekly Timesheet Record

The survey results showed a general positive outlook on the effectiveness of the weekly timesheet record for team and individual accountability, time management, and task completion with all questions receiving over 57% positive feedback. Notably, the tool was most effective in keeping individuals and teams accountable with over 62% of survey respondents agreeing or strongly agreeing to its effectiveness.

The weekly timesheet record was introduced to capstone teams immediately after teams were formed at the beginning of Fall 2024. The tool was used up to the middle of the Spring 2025 semester where all accountability reporting was switched to the daily task record yet to be discussed.

As part of efforts to assist students and capstone teams to manage their time effectively, the timekeeping record made clear how much time each student was spending on the project. This practice helped teams account for students who might be spending considerably less time on the project compared to their teammates or inversely, might be spending disproportionately more time working on the project than their teammates.

In professional practice, engineers, especially in the private sector, account for hours spent working on various projects so that their company can bill the client for completed work. The capstone course was designed to introduce the concept of billable hours to students, similar to professional practice. The weekly timesheet was utilized throughout the administered period by most teams. However, it was unclear how students were keeping track of hours as there were noticeable differences between teams and between individuals on the same team.

For example, in Fall 2024 the team with the most hours spent on the project reported 342 hours, while the team with least number of hours reported 109 hours, showing a significant difference between teams. In another example, on the team with the most hours, the student who spent the most hours reported 108 hours while the student with least number of hours reported 47 hours. The discrepancy between teams and within teams was the main concern for this tool. Overall, professors found this tool to be favorable in keeping students accountable as students did not have significant issues completing sheets

Accountability Tool #3: Daily Task Record

Over 65% of student respondents were agreeable to the effectiveness of the daily task record for all questions asked in this section. Students found the tool most effective for individual accountability and individual task completion with 73% of student respondents agreeing or strongly agreeing.

Student participation and enthusiasm waned towards the middle of Spring 2025. The quality of student work dropped and student collaboration within teams was at the best minimal. This is typical of seniors in college who are nearing graduation. As a countermeasure to this troubling trend, professors introduced the daily task record to replace the previously used accountability tools. The daily task record was an online Microsoft Excel workbook assigned to each team.

Daily task records are utilized in some industries but are not a prevalently used tool. This tool worked for the capstone course because the class met only twice a week, so students were not burned out from completing this task every class period, especially since it had replaced the other accountability tools. The general reception to the daily task record by the students was positive, especially since it replaced the other forms of accountability utilized in the course. The daily task record was highly effective in monitoring accountability for individual students and helped curb the loss of motivation from students as they realized that there would be individual grade consequences. Additionally, this helped to increase student productivity in the last few weeks of the semester.

Accountability Tool #4: Class Attendance Sheet

The class attendance sheet received generally favorable responses. The survey results highlight that the tool was most effective for individual and team accountability as Q19 and Q20 received the highest percentage of agreeable responses with 67% and 61%, respectively.

The tool was used until the end of Fall 2024 and discontinued due to perceived ineffectiveness from the viewpoint of professors at the time. The tool's ineffectiveness was corroborated by student survey data comparing the five accountability tools, the results of which will be presented in a later section. Senior design capstone courses usually have a few classes with direct instruction or lectures. Most of the class periods after the course introduction and design overviews are utilized in team design work and self-directed team collaboration. The trend was the same in this capstone course as well. In previous iterations of the capstone project, instructors realized the ineffective use of class time in working towards achieving team and individual goals. Some students would leave early on team workdays and hence negatively affect team productivity during the scheduled class times. Hence, to potentially mitigate this unproductive trend, the attendance sheet was implemented to further highlight the importance of efficiently utilizing the scheduled class period for teamwork and for completing tasks if those class days were assigned as working sessions.

Corporate establishments and engineering firms utilize attendance sheets primarily for visitors but on occasion for employees as well, which was the rationale for implementing this accountability tool in the capstone course. The attendance sheet appeared to be effective at the beginning of the Fall 2024 semester where students were new to the course and more eager to be involved. However, the effectiveness of the tool waned towards the end of the Fall 2024 semester and throughout the Spring 2025 semester. Although students were graded on how well they filled out the sheet and utilized this tool, the grades were not a significant part of their course grade. The class attendance sheet accounted for roughly 20% of their overall professionalism grade which

was only 10% of their overall course grade and therefore students were willing to lose those points on occasion hence rendering the tool ineffective after a few months.

Accountability Tool #5: Milestone Tracker

The survey results showed a generally favorable response toward the effectiveness of the 0s and 1s milestone tracker. Specifically, over 70% of student respondents agreed that the milestone tracker was effective for team accountability, team time management, individual task completion, and team task completion.

The tool was used up to the middle of the Spring 2025 semester where all accountability reporting was switched to the daily task record yet to be discussed in this section. Project teams set monthly goals working towards milestones and conducted monthly assessments to assess if milestones were met. The interpretation of the summation of all tasks completed was as follows:

- On time and 85% complete or better (90% – 100% Excellent Management) or (85% – 89% Program Tracking Well)
- Month under 85% (75% – 84% Attention Needed) or (Below 74% Significant Attention Needed)

The primary reason for introducing this tool was to provide teams with a way to organize and work ahead towards major milestones on the project and not just the daily tasks or weekly assignments. The goal was to urge students to look ahead and know that the daily tasks and weekly assignments were to culminate into a major milestone. This gave the teams a reason to complete the tasks and assignments well knowing that the completed assignments were the building blocks to their major deliverables.

In practice, the milestone tracker is used by major corporations to keep projects on track. Project teams set monthly and quarterly milestones and conduct monthly and quarterly assessments to assess if milestones are met. The goal was to continue to remind students of the real-world applications of the capstone course through the implementation of this tool. The milestone tracker was received well by most teams. However, like other tools discussed earlier, the enthusiasm to fully utilize this tool fell as the Spring 2025 semester began.

Comparative Evaluation of the Five Accountability Tools

The results of the comparative evaluation and ranking of the five (5) accountability tools are presented in this section. Figure 8 and Figure 9 show the results from this portion of the survey.

Q31 – Promoting Individual Accountability

Over 42% of student respondents reported that three (3) tools were ‘effective’ to ‘very effective’ in promoting individual accountability. It was evidently clear that the adoption of the daily task record was significantly impactful as it was ranked highest with over 60% of the student

respondents reporting that the tool was ‘effective’ to ‘very effective’ in promoting individual accountability. The daily task record received a ‘very effective’ percentage of 48%, was over 25 percentage points higher than the next ‘very effective’ tool, the milestone tracker, which had 22%. The lowest ranked tool for individual accountability was the class attendance sheet at 15% effectiveness.

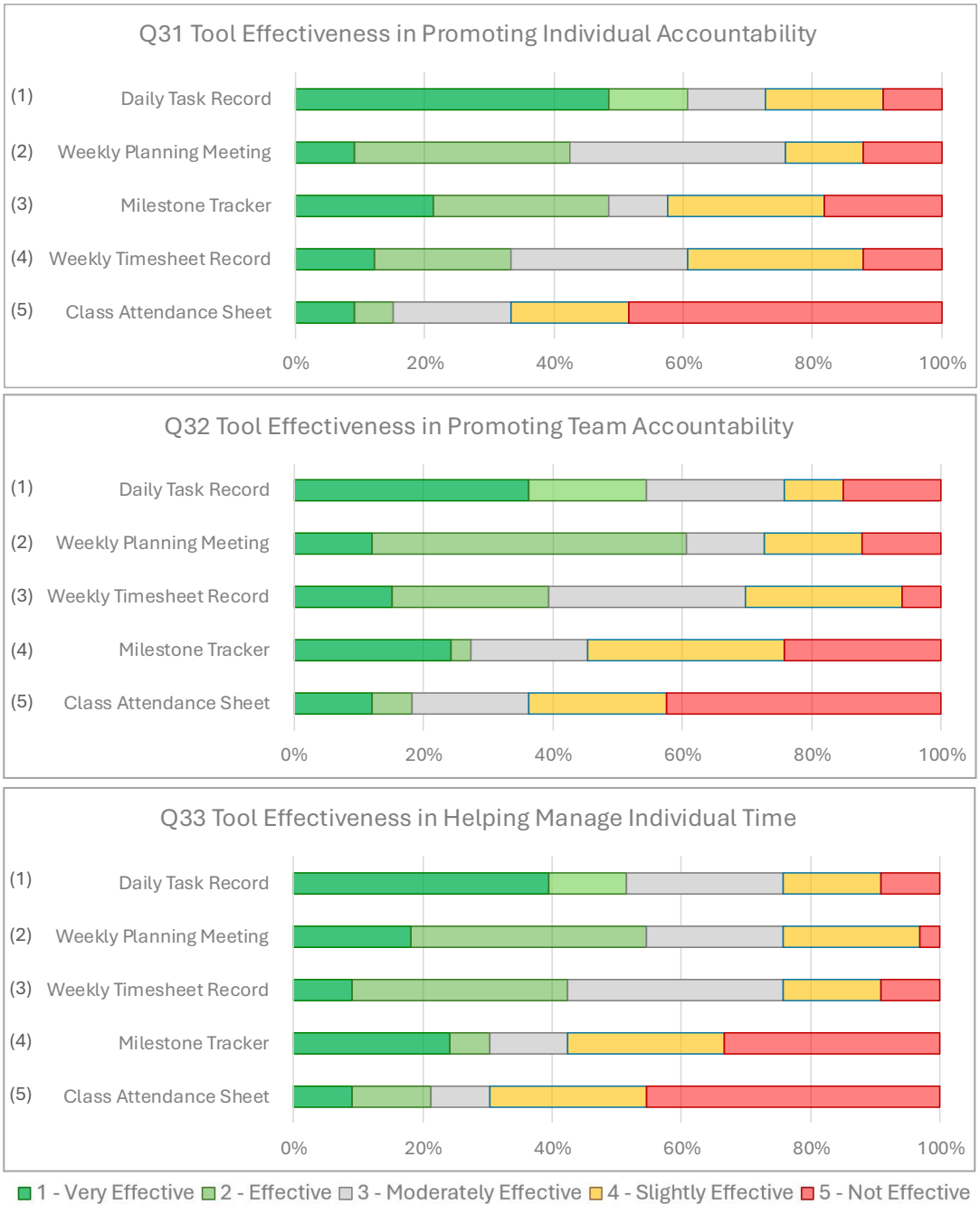

Figure 8: Comparative evaluation of five accountability tools – survey questions 31 - 33
* Tools are ranked from 1 (Very Effective) to 5 (Not Effective) *

Q32 – Promoting Team Accountability

Two (2) accountability tools—the daily task record and weekly planning meetings—stood out from the survey as being significant in promoting team accountability. The highest ranked tool was the daily task record with 36% of survey respondents viewing the tool as 'very effective'. This percentage was more than 25 percent higher than the second highest tool—the weekly planning meetings—at 12%. The lowest ranked tool for team accountability was the class attendance sheet at 18% effectiveness.

Q33 – Individual Time Management

The daily task record and the weekly planning meetings were the two (2) tools most impactful in managing individual time. Over 50% of the responses were 'effective' or 'very effective' in these two categories. However, the daily task record was viewed as more effective than all the other tools by over 15%. The lowest ranked tool for managing individual time was the class attendance sheet at 22% effectiveness.

Q34 – Team Time Management

Four of the five tools were viewed as 'effective' to 'very effective' by over 35% of respondents. The weekly planning meetings had the highest percentage (67%) of respondents in the 'effective' to 'very effective' category; however, the daily task record had over 32% of students categorizing the tool as 'very effective'.

Q35 – Achieving Individual Deadlines and Milestones

The weekly planning meetings were the highest ranked tool for achieving personal goals with a combined 'effective' to 'very effective' rating of 62%. However, the second highest ranked tool, the daily task record, had the highest percentage (37%) of students categorizing it as 'very effective'. The lowest ranked tool for managing individual time was the class attendance sheet at 22% effectiveness.

Q36 - Achieving team deadlines and milestones

The weekly planning meetings were the highest ranked tool for achieving team goals with a combined 'effective' to 'very effective' category of 67%. However, the second and third highest ranked tools, the daily task record and milestone tracker, had higher percentages, 30% and 33% of students categorizing them as 'very effective'. The lowest ranked tool for managing individual time was the class attendance sheet at 18% effectiveness.

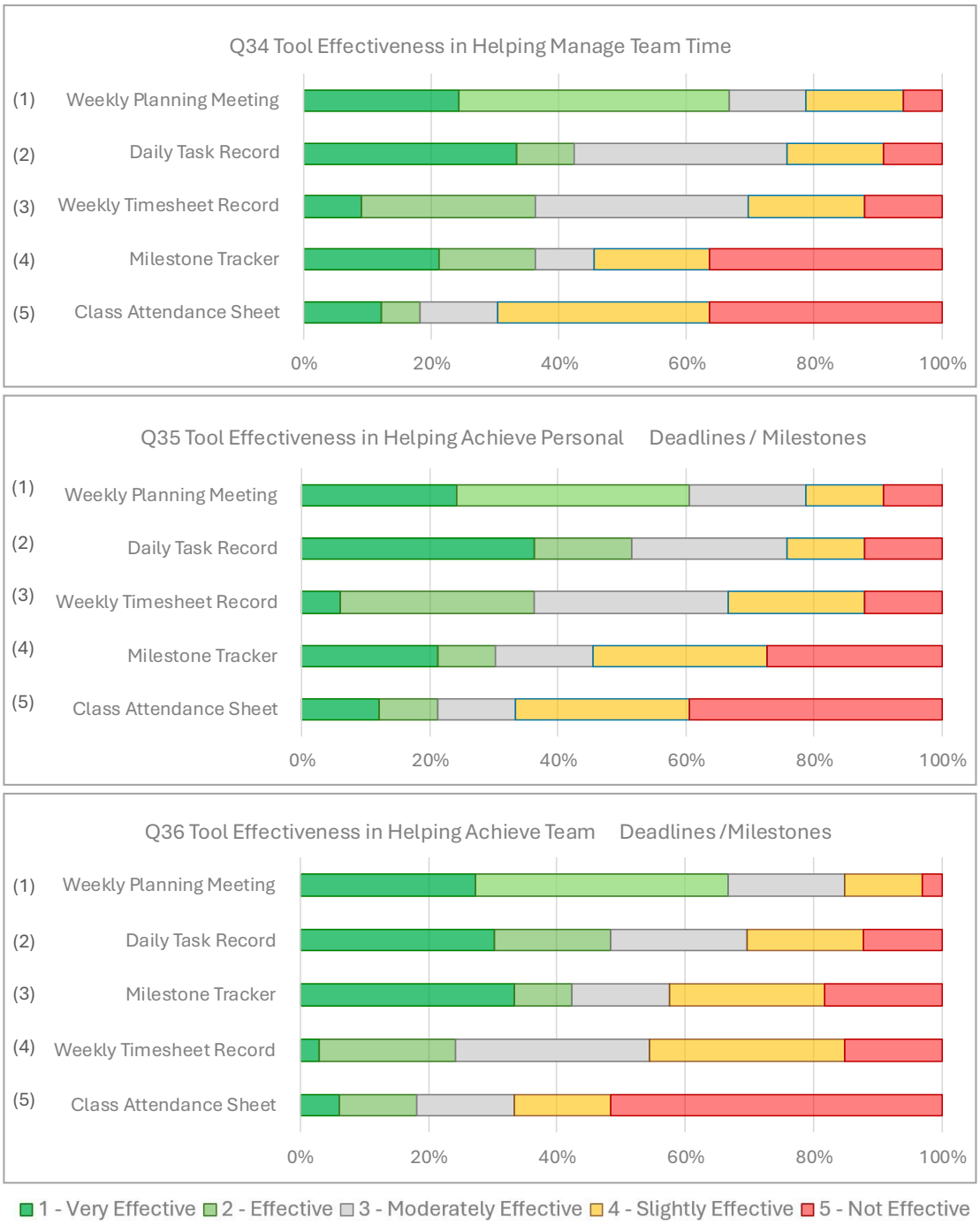

Figure 9: Comparative evaluation of five accountability tools – survey questions 34 – 36
* Tools are ranked from 1 (Very Effective) to 5 (Not Effective) *

CONCLUSION

This study evaluated the perceived effectiveness of five accountability reporting tools implemented in a design-build engineering capstone course. Results indicate that individual-focused strategies are most effective for promoting personal accountability and task completion, while team-focused strategies are more effective for coordinating collective effort and achieving team milestones. A strategic combination of accountability mechanisms can enhance student engagement and better prepare students for professional engineering practice.

Five (5) different tools were utilized during the academic year: 1) Weekly Planning Meetings, 2) Weekly Timesheet Record, 3) Daily Task Record 4) Class Attendance Sheets and 5) Milestone Tracker.

Instructor observations mostly aligned with student perceptions, reinforcing the effectiveness of higher-stakes and more frequent accountability mechanisms. Low-stakes or attendance-focused tools demonstrated diminishing effectiveness over time.

These findings suggest that accountability mechanisms are most effective when aligned with specific instructional objectives and implemented as part of a strategic combination rather than in isolation.

This study highlights the value and effectiveness of team and individual accountability tools utilized in a civil and construction engineering capstone design-build course. Ultimately, with a strategic combination of the accountability tools presented, instructors can successfully simulate real-world environments to prepare graduating engineering students to function as effective and invaluable team members in a professional environment.

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APPENDIX

ADMINISTERED SURVEY (TEXT ONLY)

Capstone Course Management Tools – Student Feedback Survey

This survey inquires about the effectiveness of the different course management tools used in the 2024-2025 CIVL/CONE Capstone Design Course in achieving individual and team outcomes for 1) Accountability 2) Time Management and 3) Achieving Goals. This survey will provide essential feedback on the tools below and will be invaluable input on the future utilization of these tools to manage the Capstone Design class.

Course Management Tools Used

A) Team Weekly Planning Meeting with Minutes
B) Team and Individual Time Sheet Record
C) Personal Daily Task Record
D) Class Sign-in/Sign-out Sheet
E) 0s and 1s Milestones Table

Description: Please rate your level of agreement with the following statements regarding each of the class management tools used in the capstone course.

Scale:

1. Strongly Agree
2. Agree
3. Neither Agree nor Disagree
4. Disagree
5. Strongly Agree

Section A: Weekly Planning Meeting with Minutes

Description: Teams were required to hold a planning meeting once a week for at least 15 minutes. Teams were required to keep a living document of meeting minutes to record what was discussed during their weekly planning meetings.

Q1. The team weekly planning meeting with minutes helped me stay personally accountable
Q2. The team weekly planning meeting with minutes helped our team stay accountable to each other
Q3. The team weekly planning meeting with minutes helped me manage my time effectively during this course
Q4. The team weekly planning meeting with minutes helped our team manage time effectively during this course
Q5. The team weekly planning meeting with minutes assisted me to complete assigned tasks to meet project deadlines and milestones
Q6. The team weekly planning meeting with minutes assisted our team to complete assigned tasks to meet project deadlines and milestones

Section B: Team and Individual Time Sheet Record

Description: Individual team members were required to record their ‘billable’ hour of work on the project which created a weekly sum for individual and team hours, as well as overall hours spent working on the project.

Q7. The time keeping record helped me stay personally accountable
Q8. The time keeping record helped our team stay accountable to each other

Q9. The time keeping record helped me manage time effectively during this course
Q10. The time keeping record helped our team manage time effectively during this course
Q11. The time keeping record helped me complete assigned tasks to meet project deadlines and milestones
Q12. The time keeping record helped our team complete assigned tasks to meet project deadlines and milestones

Section C: Personal Daily Task Record

Description: Individual team members, during class periods, were responsible to record tasks they were working on (or reviewing) and personal deadlines for completing those tasks.

Q13. The personal daily task record helped me stay personally accountable for daily work
Q14. The personal daily task record helped our team hold each other accountable for daily work
Q15. The personal daily task record helped me manage time effectively during this course
Q16. The personal daily task record helped our team manage time effectively during this course
Q17. The personal daily task record helped me complete assigned tasks to meet project deadlines and milestones
Q18. The personal daily task record helped our team complete assigned tasks to meet project deadlines and milestones

Section D: Class Sign-in/Sign-out Sheet

Description: Individual team members were to sign in on a sign-in sheet upon arrival to class (work) and sign out when leaving class (work).

Q19. The attendance sheet helped me stay personally accountable for attendance
Q20. The attendance sheet encouraged team accountability for class attendance
Q21. The attendance sheet helped me manage time effectively during class
Q22. The attendance sheet helped our team manage time effectively during class
Q23. The attendance sheet helped me complete assigned tasks to meet project deadlines and milestones
Q24. The attendance sheet helped our team complete assigned tasks to meet project deadlines and milestones

Section E: 0s and 1s Milestones Table

Description: Teams used the method of 0s and 1s (0 for missed milestone deadlines and 1 for met milestone deadlines) to keep track of project progress.

Q25. The 0s and 1s Milestones Table helped me stay personally accountable
Q26. The 0s and 1s Milestones Table helped my team stay accountable to each other
Q27. The 0s and 1s Milestones Table helped me manage time effectively during class
Q28. The 0s and 1s Milestones Table helped our team manage time effectively during class

Q29. The 0s and 1s Milestones Table helped me complete assigned tasks to meet project deadlines and milestones

Q30. The 0s and 1s Milestones Table helped our team complete assigned tasks to meet project deadlines and milestones

Section F: Comparative Evaluation of the Five Tools

Description: Please rank how effective you found each of the following tools in each category. Please **drag and drop** the options to rearrange the ranking order.

Course Management Tools Used

A) Team Weekly Planning Meeting with Minutes
B) Team and Individual Time Sheet Record
C) Personal Daily Task Record
D) Class Sign-in/Sign-out Sheet
E) 0s and 1s Milestones Table

Ranking

1 – Very Effective, **2** – Effective, **3** – Moderately Effective, **4** – Slightly Effective, **5** – Not Effective

Q31. - Promoting individual accountability
Q32. - Promoting team accountability
Q33. - Individual Time Management
Q34. - Team Time Management
Q35. - Achieving individual deadlines and milestones
Q36. - Achieving team deadlines and milestones