Evaluating Students' Perceptions of Executing a Construction Lab Project Using Procore®

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Abstract:

Construction education benefits from establishing a strong relationship with real-world industry practices. One important practice is the knowledge of software used in the industry to simplify the complex construction workflow and tasks throughout project execution. Procore® is considered a leading construction software providing a connection between technology and industry trades. The cloud-based software provides a central repository for the contract documents, e.g. bidding documents, prime contracts, change orders, drawings, and specifications, and enables sharing the project information with all project participants. While it is still needed to provide evidence-based studies measuring the effectiveness and transferability of implementing any individual software into CM education, the major benefits of similar technology integration in CM education reported by several studies are technical industry preparedness, improved learning outcomes, and increased student engagement in the course materials.

This study assesses CM students' perspective and experience of using Procore® in a sophomore-level CM course in the Fall semester of 2023 at the School of Engineering, Computing, and Construction Management (SECCM) of Roger Williams University. This course comprises a three-credit lecture with an associated one-credit construction lab. There are a total of 76 students enrolled in one of three lecture sections and one of seven lab sections. The lab section allows students to apply topics taught in the lecture sections and construct a two-story single-family structure in the CM lab facility space that includes a foundation, wood framing, mechanical, electrical, and drywall. Historically, students were asked to submit lab reports after each lab session as weekly assignments. However, in the Fall 2023 semester, the course instructors changed the weekly assignments from lab reports to a series of Procore® deliverables. The content of the previous vs. new weekly deliverables is similar but is now delivered in a way that more closely aligns with real-world industry practices. Students in each lab section were given the roles of either a General Contractor or a Subcontractor, each with specific Procore assignments after every lab session. Roles were switched each week. This approach aims to transfer the knowledge of a commonly used tool while improving their leadership abilities and communication skills.

The main objective of this study was to evaluate the effectiveness of implementing Procore® into the lab assignments on the students' learning, teamwork, and lab activity engagement. In order to accomplish the study's main objective, a designed quasi-experiment survey was sent to the students asking for their feedback. The survey included questions aimed at the students' perception of using Procore during and after the lab session to accomplish individual and group assignments. The results of this study support the development and implementation of practical collaborative training for construction education using real-world construction industry tools and software. This technology-based training can also inform the CM educational sector about the opportunity for utilizing this or similar project-controlling software in the classroom for semester projects to easily share the project information and communicate with students while monitoring their progress.

Keywords: Construction management education, Procore®, Real-world industry practices, Student engagement, Construction lab.

1. Introduction

The construction industry has been actively adopting new technologies to improve the collaboration and communication between the members involved in a project. Effective communication and project control in the construction industry has been shown to enhance the ability of the involved stakeholders to make better decisions and reduce the long-term risks to the project performance [1]. Almost every technology or tools currently being used by construction industry is to provide a better coordination, reduced errors and miscommunication, omissions and conflicts.

Higher education learning happens through activities during class time and assignments to reinforce learning outside of the classroom [2]. Since many Construction Management (CM) courses focus on team activities and hands-on projects, the CM programs should strive to ensure effective introduction and leveraging of these collaborative tools for student teams to simulate a real-world experience.

Several studies have investigated essential training in CM courses to advance construction industry integration with the curricula to ensure students enter the workforce with adequate technology skills and knowledge. For example, Colorado State University's (CSU) Construction Management Department launched an industry-sponsored pilot program including courses that focuses on integration Building Information Modeling (BIM) into CM education [3]. The students developed BIM-enabled workflows and industry best practice for lessons on various construction practices (divisions, e.g. masonry, steel, wood etc.) encapsulating the same input and output information that would be required in a more traditional curricula with the advantage of an interactive learning environment and potential for automated grading. They were then asked for their perception and feedback on their learning environment. It was shown that the interactive and visual nature of the modules engages a high level of spatial cognition and critical thinking among students while preparing the students with a cutting-edge software skill.

Zhang et al. [4] studied approaches that improve the students' problem-solving skills in civil engineering and construction management education. They used a teaching-learning experiment in a civil engineering education program by role-playing with a real-world project using the procedures of the BIM Project Execution Planning Guide and process mapping. Their results based on the surveyed students showed that this technical tool helped students managing the lifecycles of their projects by providing smooth communication, eliminating mistakes and improving project quality. Further, the students agreed that the real-world collaborative design and construction integrated project assisted their learning process.

Similarly, Kurzinski et al. [5] investigated student feedback on adopting an innovative learner-centered technology-rich approach in CM education for schedules and project progress using reality capture (ReCap). Results from this study indicated that the use of ReCap technology was an effective approach to learning and observing the construction project schedule progress compared to the traditional lecture-based course with a conventional project site visit.

Majority of the previously integrated technologies in the CM education has been on implementing visualization tools such as BIM or extended reality equipment in the learning process of the CM students to prepare them for their technical skills and leadership roles. Therefore, there is a need for evidence-based studies to measure the effectiveness of collaborative project and document control tools in construction management curricula. For this purpose, current study discusses the usefulness of integrating a project monitoring and controlling tool; Procore® [6], for the assignment deliverables in a construction lab course in higher education. Consequently, the effectiveness of this tool in the course regarding students' perception, agreement, and satisfaction was evaluated per next sections.

2. Methodology

2.1. Construction Productivity and Project Management Platforms

Construction projects and their workflows are intrinsically complex, with compliance regulations, teams dispersed across the site and office, tight budgets, and tighter timelines. Therefore, it is critical for the construction management teams to stay in control, with full project visibility. Professional construction management software helps construction teams to obtain and maintain control while improving productivity, profitability, and construction site safety.

There are several construction management platforms such as Procore®, CMiC, Oracle Primavera Cloud, ProjectSight, PlanGrid, and Autodesk Construction Cloud. that are currently being used in industry to foster an automated process for the time-consuming and complex collaborations in a construction project. All these platforms eliminate manual, paper-based processes and unify workflows within one digital system while each of these platforms might have various unique features from each another.

Procore® is currently gaining interest in the construction industry due to its affordability, effective communication, easy project control, and document sharing. Procore is a comprehensive digital solution for managing construction projects from start to finish. This cloud-based tool can be used from the preconstruction stages of design and cost estimates through project management, workforce management, and construction intelligence. Procore® cloud-based construction management software allows teams of construction companies, property owners, project managers, contractors, and partners to collaborate on construction projects and share access to documents, planning systems and data, using an Internet-connected device. Procore® claims to be the construction industry's leading construction management software that fully integrates with a number of other software specifically the financial and estimating software.

Procore® pursues construction management in several different ways including easy document searches, automated delivery of documents, and revisions or responses to team members. Procore's drawing tool gets top reviews from companies using the software. The tool is conveniently simple to use and efficient due to being a cloud-based platform. Procore® also speeds up the Request for Information (RFI) process, making it simple to assign people to respond and instantly link drawings and other information. Procore makes communication between all team members easy, and it works across all devices and platforms. Daily job reports and inspection reports are other features Procore® brings to projects and construction firms. Procore® offers easy access to anyone involved in a project without additional expensive software licenses or lengthy, drawn-out onboarding processes for subcontractors and consultants. It seamlessly connects job field sites with management team at the offices through the mobile capabilities.

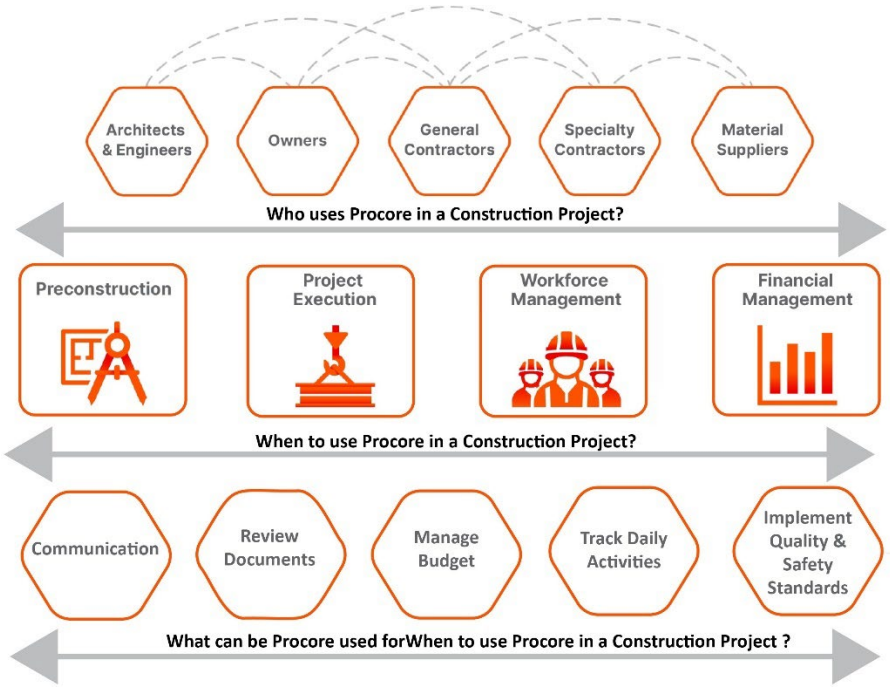

Figure 1. *Procore Workflow Details When to use Procore in a Construction Project*

2.2. Procore Integration in CM Education: Students' Perception

This paper used a designed quasi-experiment survey to assesses CM students' perspective and experience of using Procore® in a sophomore-level Methods and Materials CM course in the Fall semester of 2023 at the School of Engineering, Computing, and Construction Management (SECCM) of Roger Williams University (RWU). The integrated CM course in this study course includes a three-credit lecture with an associated one-credit construction lab. A total number of 76 students enrolled in one of three lecture sections and one of seven lab sections with an average number of 11 students in each lab. This course is the second in a series of two Methods and Materials courses, with the first being offered in spring semester of freshman year. Students in this course are expected to apply topics taught in the lecture sections in the lab to construct a two-story single-family structure in the CM lab facility space. This structure includes a concrete masonry unit (CMU) foundation, wood framing, composition shingles, vinyl siding, electrical, plumbing, and drywall. Historically in both courses in this series, and similar to a traditional construction lab course, students were asked to submit lab reports after each lab session as weekly assignments.

However, in the Fall 2023 semester, the course instructors changed the weekly lab reports to a series of Procore® deliverables. The content of the previous vs. new weekly deliverables is similar to ensure the same learning outcomes were achieved per the course syllabus but was delivered in a way that more closely aligns with real-world industry practices. Students in each lab section were divided into either a General Contractor or a Subcontractor group, each with specific Procore® assignments after every lab session. Roles were switched each week. The weekly deliverables included individual observations, a group daily log to be submitted during the lab session in Procore®, post-lab group deliverables including weekly meeting minutes, RFIs, and product data submittals to be submitted, responded to, and returned by a designated member of each group. This assignment delivery method was selected to transfer the knowledge of a commonly used tool while improving their leadership abilities and communication skills.

The main objective of this study is to evaluate the impact of implementing Procore® into the lab assignments on the students' learning, teamwork, and lab activity engagement.

In order to accomplish this objective, the link to a survey designed in Qualtrics^{XM} [7] was emailed to the students with voluntary participation to ask for their feedback using this tool in this course compared to the lab report used in the first methods and materials course taken the previous spring. There were six multiple-choice questions, one scaling question, and two short answer questions in the survey, aimed at the students' perception of using Procore® during and after the lab session to accomplish individual and group assignments. The students' perceptions and responses have been recorded and reported as described in the following section.

3. Results and Discussion

The participation rate was 59% with 45 recorded responses out of 76 students. Among the students who responded to the survey, 84% were Sophomore and 16% were at the Junior level. As **Figure 2** shows, more than half of the participants indicated having experience working with Procore®, mostly with other CM courses at RWU. 42% of the participants stated this was their first experience using Procore®.

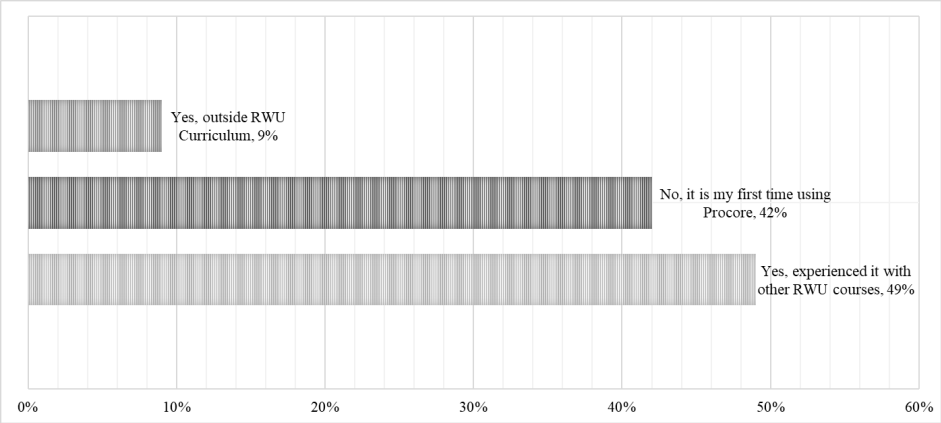

Figure 2. *Participant's Experience with Procore®*

Using a 5-point Likert scale, students were asked to provide their feedback on the difficulty of using Procore® for submitting the assignments and recording lab activities. As indicated in Figure 3, 38% of students found it extremely or somewhat easy to use with an additional 31% responding neutrally. When asked if students would prefer to submit lab reports as they had in the previous course, the majority (60%) said no, implying that Procore deliverables were preferred by most students (**Figure 4**).

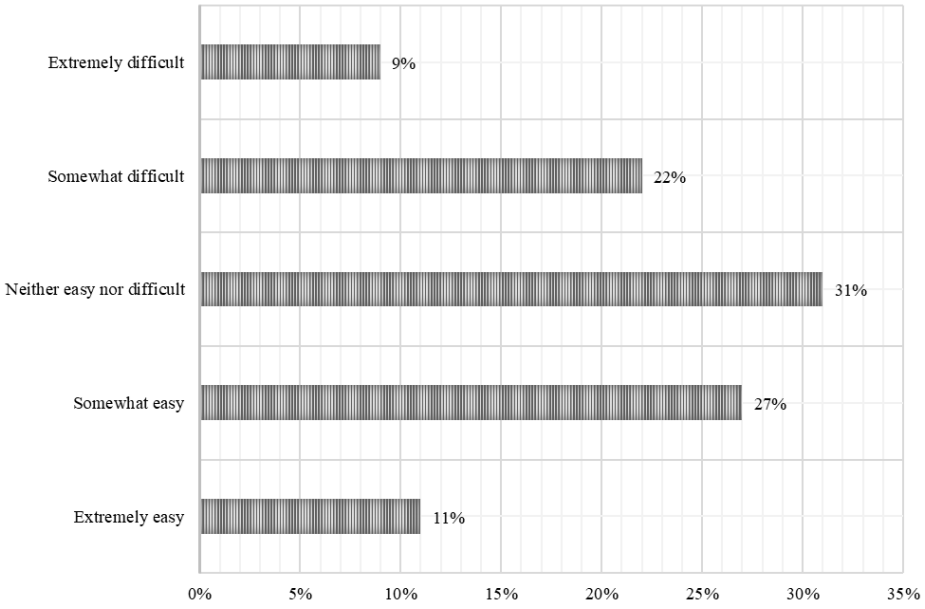

Figure 3. *Students' Perception on Level of Difficulty for Using Procore®*

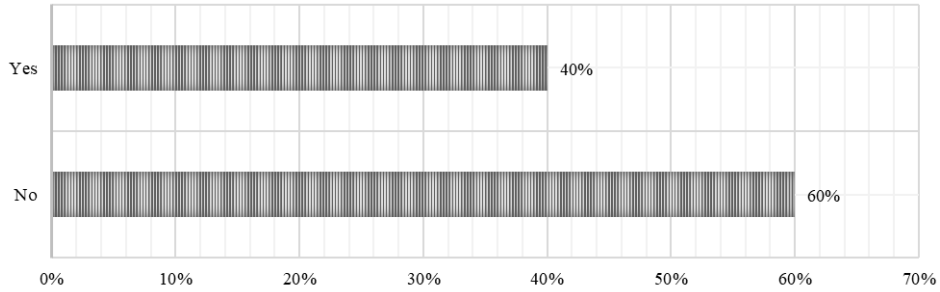

Figure 4*. Students' Responses to the Question: "Would you prefer the course had the lab report assignment delivery style as previous years?"*

Students were also asked to state their level of agreement on whether or not using Procore® has provided them with a real-world experience. Per the students' responses shown in **Figure 5**, 82% of students either strongly agree or somewhat agree that the integration of Procore® with the lab assignments and activities had provided a real-world industry experience after using Procore®.

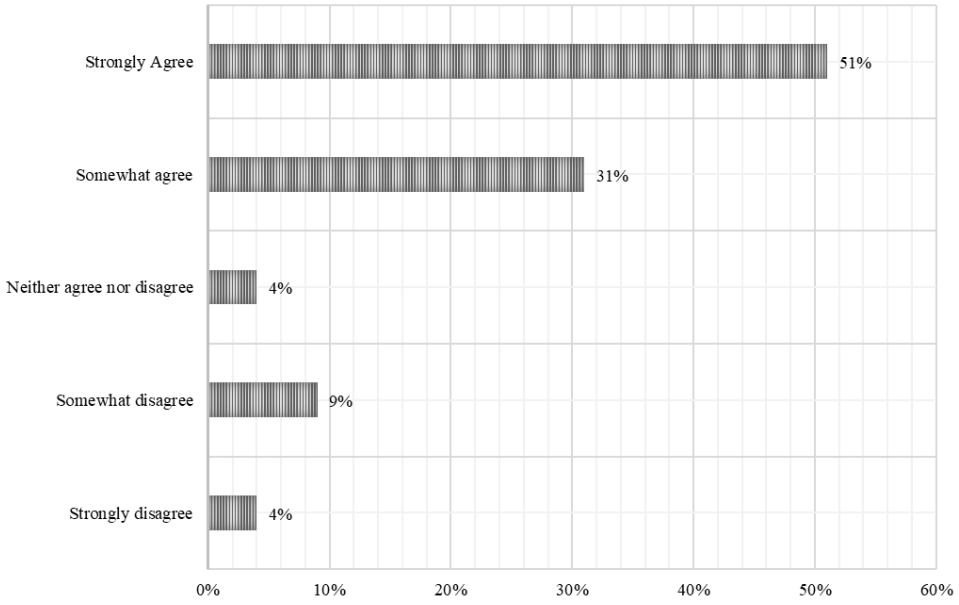

Figure 5. *Students' Level of Agreement on Using Procore Providing Real-time Industry Experience*

Similarly, the students were asked in another question to share the level of their agreement on whether or not working with Procore® during the lab sessions has increased their participation in the class activities. Based on the data shown in **Figure 6**, 29% and 47% of the participants respectively strongly and somewhat agreed that their class participation was increased by using Procore® during the lab activities.

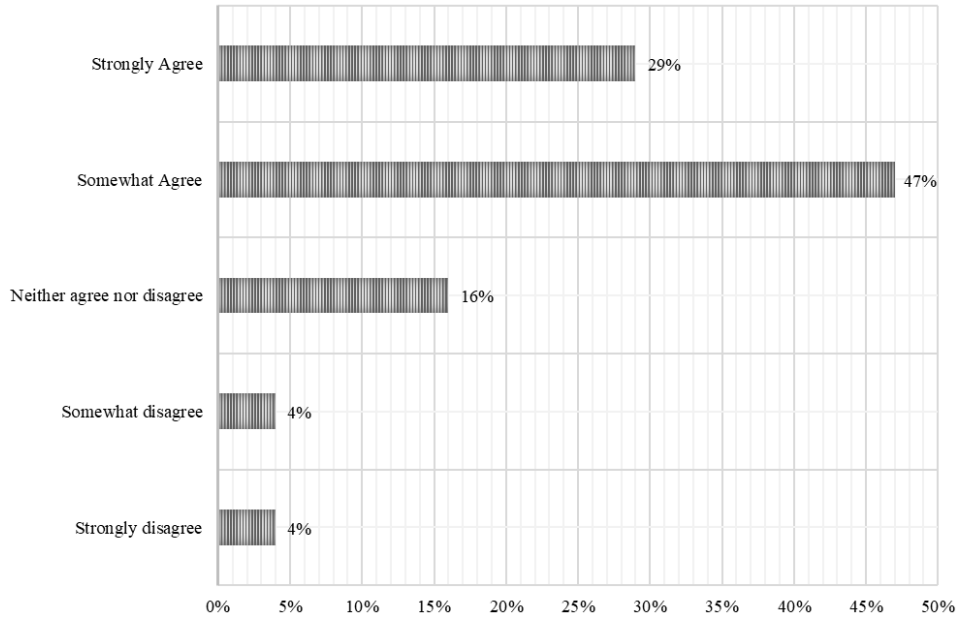

Figure 6. *Students' Level of Agreement on Working with Procore® During the Lab Sessions Increasing Their Participation in the Class Activities*

The final question compromised three slider-style questions asking the students about their competence using Procore with their team in the current or future course(s), their level of confidence in having Procore®

as a skill on their resume, and their feedback on how much they believe this tool is useful in controlling the documents of a construction project. **Figure 7** shows the recorded responses on a scale of *0= strongly disagree* to *100= strongly* agree.

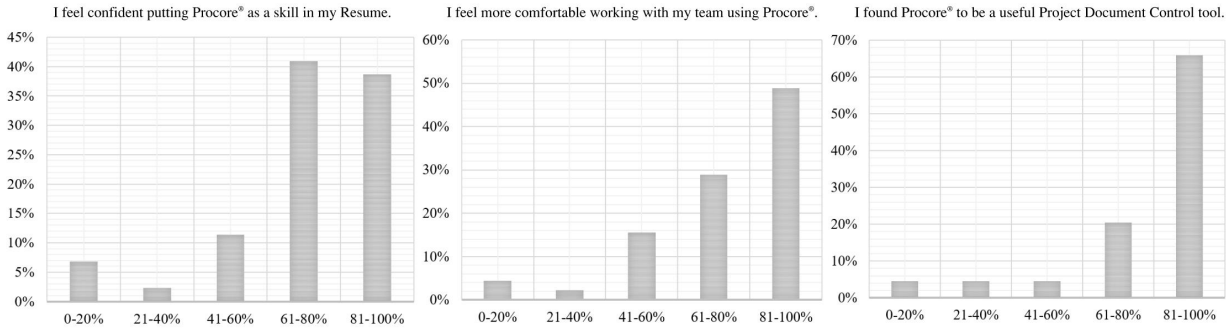

Figure 7. *The students' Perception about Level of Competence and Confidence in Using Procore®*

The students' overall level of agreement on the usefulness of Procore integration with this construction lab course is reported in (**Table 1**) with statistical data analysis based on the Likert scale rating system [8]. The data analysis confirmed the results in **Figure 5** and **Figure 6** that implementing this tool in the course deliverables has brought satisfaction to a construction lab project learning environment by not only providing a real-world industry experience but also by improving the class participation for the students.

Table 1. *Data Analysis Results of Student's Agreement and Perception with Using Procore® in the Lab*

Question	Mean ± Standard Deviation	P-value	Agreement (%)
Working with Procore® in the lab section of the course provided a real-world industry experience for me.	4.16 ± 1.07	<0.001	82%
Working with Procore® during the lab (e.g. safety observations) increased my class activity.	3.91 ± 1.01	<0.001	76%
I feel confident putting Procore® as a skill in my Resume.	4.02 ± 0.60	<0.001	80%
I feel more comfortable working with my team using Procore®.	4.16 ± 0.62	<0.001	78%
I found Procore® to be a useful Project Document Control tool.	4.39 ± 0.68	<0.001	86%

4. Conclusion

The construction industry continues to advance technologically, improving the complexity of coordination and collaborations in a project. Construction-related education is aimed at preparing students for current and future industry practices. To equip the future workforce with the required skills in the construction industry, these tools should be integrated and assessed in CM education and university curricula. This study evaluated student perceptions and experience on using Procore® as a project and document control tool integrated with the assignment deliverables of a construction methods and materials lab course, in the Fall semester of 2023 at the School of Engineering, Computing, and Construction Management (SECCM) of RWU.

This observational study has used a designed quasi-experiment with a questionnaire survey answered voluntarily by 59% of the students in the class to assess their level of agreement on effectiveness of using Procore® tool for project deliverables instead of traditionally-delivered lab reports.

Based on the data, the students who participated in the survey showed the highest level of agreement; 86%, on the technical tool, Procore®, being a useful Project Document Control tool. With an 82% of students' agreement level for having a real-world industry experience with using the tool, the effectiveness of the tool appeared to be achieved for the course deliverables. Moreover, the tool seemed to provide a reasonable level of difficulty for a sophomore-level CM course since only 9% of students found the tool to be extremely difficulty. Although the level of satisfaction for learning process and the agreement of the effectiveness of the tool has been shown per discussed and reported data, there are still 40% of the students who preferred the lab reports to using Procore for the assignment delivery style. Therefore, further investigation on how to implement similar project and document control tools with a CM lab assignments and class activities is encouraged.

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