Work in Progress: Students' Reflection Quality and Effective Team Membership

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Abstract
This work in progress paper is to investigate the relationship between two self-regulation strategies as self-reflection and collaborative working in teams.
Effective instructors employ various strategies to enhance students' learning outcomes in engineering classes. The primary goal of these strategies is to involve students in the learning process actively, and to promote students' self-regulated learning strategies. Students' reflection and ability to work in teams are two such techniques, which could enhance the learning outcomes and self-regulation of students. In this exploratory study, we collected data from 114 First-Year Engineering students and investigated the relationship between students' reflection quality and their becoming a better and active team member. We used CourseMIRROR mobile learning system to collect students' reflections during an academic semester. We also evaluated each student reflection based on its quality. The reflection quality here refers to specificity or vagueness of reflections. Based on our prior research on the significance of the reflection quality on student learning [1], we developed a coding schema to specify the degree of reflection's quality. We further used the *Comprehensive Assessment of Team Member Effectiveness* (CATME) for peer and self-evaluation on five dimensions. Initial findings reveal statistically significant relations between five aspects of CATME and reflection's quality. We also conducted linear regression analyses to explore how these five CATME dimensions predict reflection quality scores.

Keywords: team membership, reflection, self-regulation, first-year engineering, technology

Introduction

In a student-centered learning environment, educators use various techniques in their classes to ensure students' learning and engagement [2]. These techniques are used to enhance both students' learning outcomes and students' self-regulated learning. Instructors in various disciplines, including engineering education, are working towards using some strategies to ensure that they help the students for enhancing their ability to self-regulate themselves and get involved in the active learning process.

Self-regulated learning (SRL) is a complex process and requires attention to cognitive, motivational and contextual elements [3]–[5]. Pintrich [6] described this process as "an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behavior, guided and constrained by their goals and the contextual features in the environment (p. 453)." This definition asks for the active involvement of students, goal orientation, use of learning strategies to enhance learning, and providing a stimulating learning environment for increasing student motivation and learning.

Prior literature has shown that unless taught or incorporated in the classroom, most students lack SRL skills. For instance, students don't monitor and evaluate their performance [7], [8] and have low motivation to work on their studies [5], [9]. Educators in the domain of engineering education implement strategies in their classroom to enhance students' ability to self-regulate themselves [10]. These strategies include using collaborative learning [11], [12], problem-based learning [13], [14], strategies to ensure metacognition including self-reflection [3], [15], and use of technology to support learning [16].

In this study, we are focusing on exploring the relationship between two of the self-regulation strategies 1) students' reflections, and 2) their peer and self-evaluation of teamwork in an engineering classroom. In the next section, we present the literature review to describe reflection as a metacognitive strategy and the team based working. We introduce two educational technologies that we used to collect data. Followed by sections of research methods, data analysis, results, conclusions and future directions.

Literature Review

Self-regulation is a process of transformation in learners, where they utilize their mental abilities and convert them into academic learning [17], [18]. Literature indicates that process of self-regulation allows people to identify opportunities in situations and enable them to be communicative with other people [19]. Further, these strategies involve them in self-reflection process [18], and teamwork [12], [20]. Studies have shown that self-regulated learning strategies are associated with academic success [21]–[23], and promote conceptual gains in students [24], [25].

Self-regulated learning (SRL) involves the uses of metacognitive strategies including introspection, consciousness, and reflection [26], [27]. Reflection is a process which consists of judgment and reaction [5], [18]. The reflective process involves students actively in what they are learning and identifies the strengths and weaknesses experientially [28]. Reflection thus allows the students to analyze, perform, discuss, or evaluate the beliefs and make an interpretation of their learned concepts [29]. With this process, students rationally examine the content and their understanding and consider the subject matter [30]. In the self-reflection, the learner evaluates the learning process and assesses that whether they understand the material in an interactive manner. Researchers have linked quality of reflections with student learning outcomes [31]–[33] and indicated that with a higher quality of self-reflection, students performed better and were able to achieve better learning outcomes [34], [35].

SRL is also fostered with the use of collaborative team working [36], [37]. It allows students to evolve with one another continually and foster a sense of community in the classroom [38]. The benefits of teamwork include motivating students to engage, staying focused on the task, sharing their ideas, getting involved in the decision-making process [39], and learning the competencies better [40], [41]. Further teamwork facilitates self-regulated for a variety of reasons [15] such as explicit peer feedback [42], [43], discussion to promote planning and evaluation of tasks [44], and also to promote social interactions and equity in classrooms [20], [45], [46].

Although previous studies have discussed the role of reflection as an important aspect of the collaborative learning environment [36], for blended learning [47] and also for fostering transformative learning [48], [49], they have not discussed the relationship between these two teaching strategies of SRL. The above-discussed studies have focused on three aspects: 1) role of self-reflection in SRL, 2) the role of teamwork in SRL, and 3) role of reflection in fostering a collaborative environment. Considering these two strategies of self-reflection, and team citizenship, we believe that it is pertinent to study and explore these two aspects together. Thus, in this study, we aim to explore the relationship between these two strategies.

Research Method

Site

The data is collected from a large mid-western university from the first-year engineering students of a required course. In this class, students learn to develop the solutions for engineering designs by attempting modeling challenges and practice evidence-based engineering decisions on diverse teams. "Students cover topics such as data visualization and analysis, ethics, engineering design, application of basic programming to the solution of engineering problems, development of mathematical models to solve engineering problems, teamwork skills, and professional communications [50]".

Participants

The participants were from a required course of first-year engineering students. There were 120 students in the class, where 114 students participated in this study. Participation to study was voluntary. The data was collected in Spring 2017 with the following demographics information (see Table 1).

Table 1
Demographics Information

	Male	Female	Total
Gender	94	20	114
White or European American	58	11	69
International Student of any race/ethnicity	18	7	25
Asian American	9	0	9
Two or more races	5	0	5
Black or African American	0	2	2
Native Hawaiian or Other Pacific Islander	2	0	2
Hispanic or Latin American	2	0	2

Data Collection

The data were collected from 114 students with the use of two applications 1) CourseMIRROR, and 2) CATME for reflection and team evaluation respectively. Collecting reflections in classroom settings is challenging. To address this challenging task of data collection, our research team developed a mobile application called CourseMIRROR (Mobile In-situ Reflections and Review with Optimized Rubrics) [1], [51], [52]. CourseMIRROR prompts students to write insightful reflections on concepts taught in class and for problems faced during the class. Students are asked to generate reflections after each class throughout the semester. CourseMIRROR then uses NLP algorithms to generate summaries of reflections [51]. These summaries are available to both the instructors and the students, and they allow instructors to find the difficulties and misunderstandings in students' understanding of fundamental concepts in each lecture. CourseMIRROR is tested for reflection gathering in engineering classrooms [53]. Luo & Litman [54] described the use of a quality rubric to calculate the reflection quality score of student reflection data collected through CourseMIRROR, and with extrinsic evaluation showed that both expert coded quality ratings and quality predictions are positively related with students' learning.

The reflections data for this study were collected for 30 lectures using CourseMIRROR. A total of 3432 reflections were collected from all students. The reflection was collected from two aspects: 1) muddiest point (MP) which describes the confusing aspect of the lecture, and 2) point of interest (POI) which relates to interesting aspects of the given lecture. Students were asked to write reflection specific to the attended lecture. Further, students were not given any training as the questions were simple and relevant to a specific lecture only. This self-reflection aspect allowed the student to think of lecture in a critical manner and provide their thought points about confusions and interesting aspects. We determined each reflection's quality score to determine that how specific students are regarding the confusing or interesting aspects of the given lecture. Thus reflection quality score refers to the specificity or vagueness of each reflection. Figure 1 is a revised form of existing rubric and illustrates the flowchart and mechanism of calculating each reflection's quality [55]. For each student, separate reflection quality score was calculated for MP and POI. These reflections quality scores were used in our data analysis and had not impacted students' grade in the course in any manner.

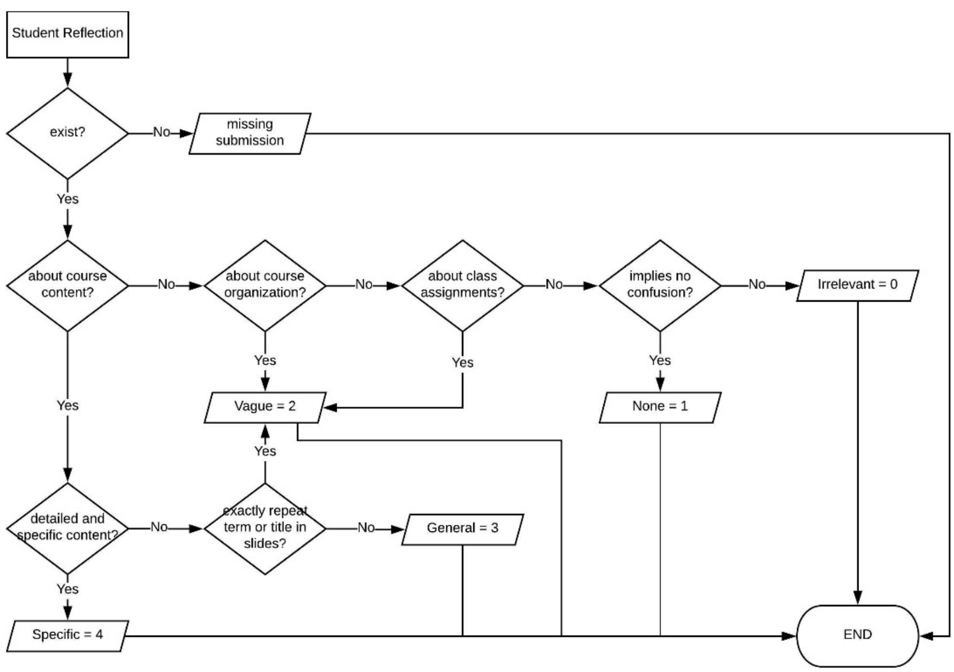

Figure 1
Flowchart for the reflection quality score

We used CATME to collect self-and peer evaluation. CATME (Comprehensive Assessment of Team Member Effectiveness) [56], [57] is a web-based tool developed for conducting peer evaluations and assess contributions of team members. CATME collects data in five dimensions 1) Contributing to the team's work, 2) Interacting with teammates, 3) Keeping the team on track, 4) Expecting quality, and 5) Having relevant knowledge skills and abilities on a rating scale. CATME is an assessment for self-and peer-evaluation of members' contributions to a team. It was developed to explain and measure teamwork behaviors that are critical for effective team functioning [57], [58]. CATME also allows instructors to assign students to teams using built-in criteria or those generated by the instructor. The peer evaluation system provides feedback to students and to the instructor about how each team member is performing [57] and informs students with good team citizenship [59].

The CATME data were collected at four different times during an academic semester where students described the team citizenship of their peers in their respective teams on five dimensions 1) Contribution to teamwork, 2) Interaction with teammates, 3) Keeping team on track, 4) Expecting quality, and 5) Having relevant knowledge, skills, and abilities.

Data Analysis

For this study, we transformed data for the purpose of data analysis. The collected reflections were in the form of textual data where each student provided their feedback on all 30 lectures. The textual data was transformed using the reflection quality score flowchart, and thus we obtained a total of 1716 POI quality scores and a total of 1716 MP quality scores. To obtain the quality score of each student we used the average points. We calculated the average mean of muddiest points and average mean for point of interest of all 30 lectures.

The CATME data was collected at four points of time and for five dimensions. To calculate the CATME based team citizenship value, we also transformed CATME data for each student. e calculated the average mean of all four data points for each CATME dimension, and for each student, we used this averaged data for conducting Pearson calculation, and for running linear regression as reported in this study. We used SPSS to conduct the data analysis.

Results

We first calculated Pearson correlation between five aspects of CATME and reflection quality. The initial correlation analysis indicated a significant positive correlation between reflection quality and all five aspects of CATME for 114 students included in the dataset.

Table 2
Correlations in the data

		Contribution to teamwork	Interaction with teammates	Keeping team on track	Expecting quality	Having relevant knowledge and skills
MP	*r*	.217*	.246**	.249**	.228*	.207*
	p	.020	.008	.008	.014	.027
POI	*r*	.223*	.258**	.269**	.221*	.214*
	p	.017	.006	.004	.018	.022

We ran linear regression analysis for CATME dimensions on muddiest point and point of interest in reflection quality. We checked the assumptions of the linear regression models. We test the linearity assumption using scatter plots. Multicollinearity in the data is checked for each regression, using multicollinearity diagnosis Variance Inflation Factor (VIF), we found little or no multicollinearity. The results are reported in the following tables

Table 3
Regression of CATME dimensions on MP

Variable	F (1,113)	p	R^2
Contribution to teamwork	5.537*	.020	.047
Interaction with teammates	7.202**	.008	.060
Keeping team on track	7.380**	.008	.062
Expecting quality	6.169*	.014	.052
Having relevant knowledge, skills, and abilities	5.037*	.027	.043

* $p<0.05$, **$p<0.01$

Linear regression analyses were conducted to evaluate the prediction of team citizenship from the muddiest point of the reflection data. The above table data shows that the results are significant which means that reflection quality using muddiest point has an effect on all CATME dimensions. The five equations take the following shape

Predicted contribution to teamwork = 0.268(MP) + 3.451
Predicted interaction with teammates = 0.305(MP) + 3.474
Predicted keeping team on track = 0.304(MP) + 3.395
Predicted expecting quality = 0.288(MP) + 3.497
Predicted having relevant knowledge, skills, and abilities = 0.253(MP) + 3.533

The accuracy in predicting the CATME relatively moderate with on average of 5-6% variance in CATME dimensions is accounted by its linear relationship.

Table 4
Regression of CATME dimensions on POI

Variable	F (1,113)	p	R^2
Contribution to teamwork	5.847*	.017	.050
Interaction with teammates	7.963**	.006	.066
Keeping team on track	8.708**	.004	.072
Expecting quality	5.740*	.018	.049
Having relevant knowledge, skills, and abilities	5.400*	.022	.047

* $p<0.05$, **$p<0.01$

Similarly, linear regression analyses were conducted to evaluate the prediction of team citizenship from the point of interest of the reflection data. The above table data shows that the results are significant which means that reflection quality using point of interest has an effect on all CATME dimensions. The five equations take the following shape:

Predicted contribution to teamwork = 0.264(POI) + 3.444
Predicted interaction with teammates = 0.307(POI) + 3.367
Predicted keeping team on track = 0.316(POI) + 3.395
Predicted expecting quality = 0.267(POI) + 3.511
Predicted having relevant knowledge, skills, and abilities = 0.251(POI) + 3.524

Accuracy in predicting the CATME relatively moderate with on average of 5-6% variance in CATME dimensions is accounted by its linear relationship.

Discussion

Self-regulated learning involves both the self-reflection (a process of judgment and reaction) and use of collaborative work (team-work). The literature presented above validated that if we introduce these strategies in classroom learning experience, they help to enhance students' learning [33]-[35], [45]-[47]. The purpose of this work in progress study was to establish the relationship between two strategies. We collected the student's data for both reflections, and the team is working with the use of educational technology tools, CourseMIRROR and CATME. CourseMIRROR where collected the data from MP and POI perspective and CATME data were collected for five dimensions. Our results reveal the results of positive correlation between these two aspects of self-regulation and indicate that both these aspects of self-regulation are positively correlated with one another.

The existing literature studies confirmed that both self-regulation strategies, are to be incorporated in in classes and both have an impact on students learning. But this study was conducted to identify the relationship between these two strategies. The initial results, as shown above, confirms the positive correlation, and also that accuracy in CATME evaluation score is moderately predictable by the reflection quality score. This is rather not surprising because both of these aspects are to enhance students' self-regulation. In our future studies, we will conduct more refined data analysis procedures to ensure the results.

Conclusion and Future Direction

Educators use multiple strategies to engage students and to enhance SRL of students. Two such strategies used widely are students' self-reflection and team citizenship in a collaborative learning environment. In this study, we explored the relationship between these two dimensions of SRL in an engineering classroom. We collected the data from 114 engineering students from a freshmen class. We used technological applications, 1) CourseMIRROR for collecting students' reflection data, and 2) CATME for collecting students self and peer evaluation on team citizenship on five dimensions. We conducted Pearson correlation and found positive, significant correlation between reflection quality scores and team citizenship. We also fit linear regression models to explain the results. These initial results indicate that these two strategies are related and reflection quality has an effect on students' becoming a better citizen in the team.

Considering the results, we conclude that we need to conduct further analysis to understand the relationships better. This version of the study is a work in progress, and we are currently in the process of conducting a time-series analysis of the data at various points in time.

In future, we plan to show results based on students' demographics information specifically the trends based on gender and ethnicity. We are also doing multiple regression analysis on the data. Further, we plan to conduct more longitudinal studies to see the effect of these two constructs together on SRL and on each other.

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