Paper Title Comparing Average Reflection Count and Specificity Scores Between Scaffolded and Nonscaffolded Students

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Abstract

This study explored how scaffolding strategies affect students' reflections regarding their learning activities. We worked with 848 students in an introductory psychology course to reflect on their learning experiences after each lecture using the CourseMIRROR mobile application. We randomly assigned students into two groups; where the first group was provided a version of the app with scaffolding features, and the second group was provided a different version without scaffolding features. Comparing reflection specificity scores shows that the scaffolded group wrote significantly more specific reflections than the non-scaffolded group. This study shows the importance of reflection scaffolding and provides a useful context for further explorations of the phenomenon.

Introduction

In recent years, fostering reflective practices in the classroom has gained attention in developing critical thinking (Bezanilla et al., 2019), metacognitive abilities (Yan et al., 2020), and adaptive learning (Carpenter et al., 2020). Reflection is a cognitive process where students engage and monitor their past experiences to understand their new knowledge (e.g., Dewey, 1933; Author, 2020). This cognitive process involves the student's ability to actively reflect on and evaluate their learning process to improve their understanding. Several studies have emphasized the benefits of reflective practices in the classroom and highlighted their effectiveness in improving students' academic achievement (Lew & Schmidt, 2011), motivation (Cavilla, 2017), and self-efficacy (Tan, 2013).

While reflection activities have positively impacted students' learning, it is often considered a challenging task to integrate these activities into large classrooms (e.g., Authors, 2020; Authors, 2018). Additionally, students who participate in such cognitively demanding activities often do not effectively reflect, and some students discuss irrelevant issues in their reflections (Authors, 2017a). One of the techniques that can help students to write more relevant reflections is scaffolding. Scaffolding has been extensively studied and shown to be effective in aiding student learning (Bruner, 1997; Cai et al., 2022; Hsi & Agogino, 1995; Prather et al., 2019; Spouse, 1998). Therefore, it is important to develop an innovative approach to integrate reflection activity into teaching and provide students with scaffolding to support their reflection writing process.

Seeing the challenge of effectively integrating reflection activities in the classroom, we developed the CourseMIRROR (Mobile In-situ Reflections and Review with Optimized Rubrics) application to facilitate the students' reflection writing process (Authors, 2015). The mobile app prompts students to reflect on each lecture's confusing or interesting aspects throughout the semester. Furthermore, the application uses NLP (Natural Language Processing) algorithms to create reflection summaries and make them available to instructors and students. Previous studies have shown that the CourseMIRROR system improved students' reflection submission process (Authors, 2022a; Authors, 2022b; Authors, 2018b) and improved different aspects of students' learning (Authors, 2022a; Authors, 2022c).

In this study, we explored how scaffolding affects students' reflections on their learning experience in an introductory psychology course. We implemented a scaffolding feature to help students write and evaluate their reflections in real-time using the NLP algorithm. Reflections are rated using a specificity score on a 4-point scale from 1 (shallow reflection) to 4 (highly

relevant reflection). We conducted a quasi-experimental study by developing and implementing two versions of the application into different sections of the course, where one version provides scaffolding during the reflection writing process, and the second version does not provide scaffolding during the reflection writing process. We instructed students to reflect using the CourseMIRROR app on what they find confusing and interesting after every lecture. The research questions guiding this study are:

1. How do reflection specificity scores differ between scaffolding and no scaffolding conditions?
2. How do reflection specificity scores relate to the number of submitted reflections?

Theoretical Framework

The relationship between behavior and learning has long been complex, reciprocal, and dynamic (Schrader & Lawless, 2004). Reflecting on learning material has been considered a benefit to learning and can be seen as part of the cyclical nature of developing knowledge (Dewey, 1997). In addition, reflecting on how one learns, considered metacognition (Flavell, 1981), is useful for students to understand so that they can better learn difficult concepts (Anwari et al., 2015; Svinicki, 2004).

Authors (2020) proposed a RILI (reflection-informed learning and instruction) model that prompts students to identify and reflect on concepts that they find confusing, stimulating their metacognition and enhancing academic success. We developed a mobile learning system called CourseMIRROR to implement RILI in classrooms, and we found that students in the RILI condition performed significantly better than the control group, and that reflection quantity and quality are associated with exam performance. CourseMIRROR allows to effectively collect and process student reflection with the help of mobile technology (Authors,

2017a). Mobile technology has been used in various classroom settings to measure and improve self-efficacy and engagement (Cibulka and Cooper, 2017; Xie et al., 2019).

Scaffolding reflections have been shown to promote higher-quality reflection behaviors. Authors (2023) found that scaffolding helped engineering students write significantly more specific reflections than students who did not receive scaffolding. Likewise, Prather and colleagues (2019) developed a metacognitive scaffolding exercise for a computer programming course. They found that although the students who received scaffolded reflection prompts had less time to complete a coding exercise in a one-hour instructional session, they completed the task with more correct answers and took less time to complete the task.

With this understanding of the literature in mind, we hypothesize that scaffolding reflections will support students in providing deeper responses and generate higher incorporation of metacognitive skills.

Method

Participants

Eight hundred forty-eight students enrolled in an introductory psychology course in a large North American University participated in this study. The students were divided into two conditions based on their course sections. Both sections were taught in person on the university's main campus, and the content and assessments across sections were identical. The research team designed reflection prompts to ask students two questions on what was confusing, referred to as the Muddiest Point (MP), and interesting, referred to as the Point of Interest (POI), after each lecture. Three hundred sixty-six students (43.16%) in the first section, referred to as Metacognition No Scaffolding (MNS), were provided with the first

version of the app without the scaffolding feature. Four hundred eighty-two students (56.84%) in the second section, referred to as Metacognition Scaffolding (MS), were provided with the second version of the app with the scaffolding feature. The reflections are collected for seven lectures, and the research team is not involved in teaching the course.

This research has received approval from the Institutional Review Board (IRB).

Instrument

CourseMIRROR is used to collect reflections and rate reflection specificity using NLP algorithms. The app uses push notifications to remind students to write their reflections after each lecture. It then provides scaffolding messages and a color bar to indicate the level of specificity in their reflections, as shown in Figure 1. The specificity score shows the relevance of the reflection with the prompt and lecture's content, using a 4-point scale from 1 (shallow reflection) to 4 (highly relevant reflection).

Analysis and Results

Four analyses were conducted to answer our research questions. The alpha for all analyses is set to .05. For the first analysis, we compare the average MP specificity score between MS and MNS groups. Assumption checking result shows that the data is normally distributed. However, Levene's test for homogeneity of variance is significant, $F(1, 676)=22.49$, $p < .001$, which means that we have to conduct an Analysis of Variance (ANOVA) using Welch's F Test. The result shows that the MS group ($M = 2.39$, $SD = .99$) submit significantly more specific MP reflections than the MNS group ($M = 2.02$, $SD = .82$) with medium effect size, $F(1, 674.28) = 27.55$, $p < .001$, $\omega^2 = .036$.

For the second analysis, we compare the average POI specificity score between MS and MNS groups. Assumption checking result shows that the data is normally distributed, and Levene's

test for homogeneity of variance is not significant, $F(1.\ 676) = .86$, $p = .355$. Analysis of Variance (ANOVA) result shows that the MS group ($M = 3.18$, $SD = .69$) submit significantly more specific POI reflections than the MNS group ($M = 2.90$, $SD = .65$) with medium effect size, $F(1, 676) = 27.71$, $p < .001$, $\eta^2 = .039$. The findings from our first and second analyses show that the group that receives scaffolding writes significantly more specific reflections than the group that does not, which suggests that the scaffolding feature can help students write more specific reflections.

We investigate the relation between the MP specificity score and reflection count for the third analysis. We conduct linear regression analysis with MP specificity score as the dependent variable and reflection count as the covariate. The data passed all assumption checking. However, the result is not significant, $F(1, 676) = .154$, $p = .695$.

For the fourth analysis, we investigate the relation between POI specificity score and reflection count. We conduct linear regression analysis with POI specificity score as the dependent variable and reflection count as the covariate. The data passed all assumption checking. However, we found no significant result for this analysis, $F(1, 676) = .564$, $p = .453$.

The result from our third and fourth analyses shows that there is no significant association between reflection specificity score and the number of submitted reflections.

Discussion and Conclusion

The results of scaffolding on the specificity of reflections agree with previous literature that the scaffolding feature is able to improve the specificity of submitted reflections (Authors, 2023; Authors, 2020). Our result aligns with previous literature on scaffolding and how it can effectively aid student learning (Bruner, 1997; Cai et al., 2022; Hsi & Agogino, 1995; Prather et al., 2019; Spouse, 1998). We find these results not surprising but confirm that the scaffolding

process does seem to influence a student's ability to be specific in their reflection. Our experiment with psychology students adds to the collection of literature on how scaffolding is able to improve reflection specificity across different fields of study.

A surprising result related to our second research question is that scaffolding provided more detailed reflections in students but did not affect the reflection count. This finding would be against our initial hypotheses, as we expect the scaffolding feature to be able to encourage students to write more reflections. Previous results have shown that the number of reflections and the quality of reflections are not always intertwined, especially when considering a student's motivational mindset (Authors, 2018a, 2017b). The findings from this study suggest that there are other variables that are also playing a role in the reflection process, and more discussion and exploration are necessary.

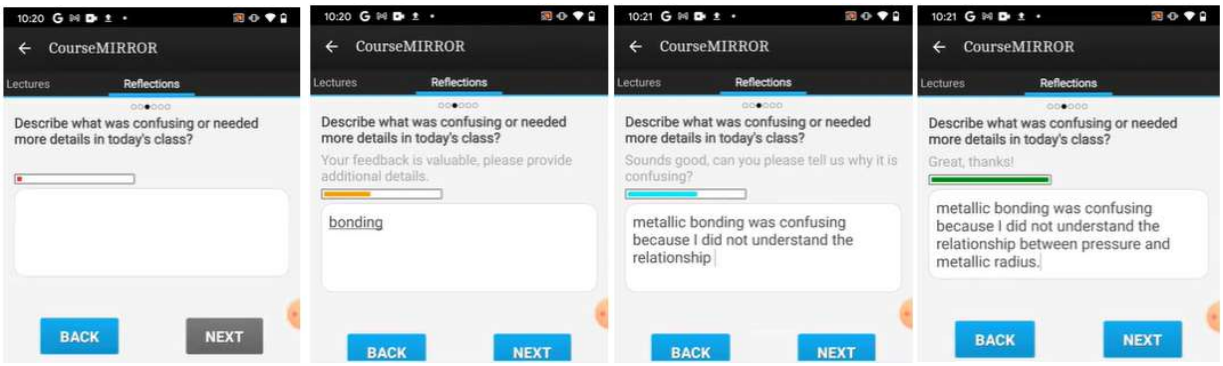
While this study has led to some interesting findings, it is important to note that the work has some limitations. Most notably, this study was done within the specific context of an introductory psychology course within one university. More data can be collected from other universities and other courses to have a better understanding of the results and their implications. We also would suggest that more work be done with students from specific backgrounds. Introductory psychology courses may end up being taken by a large swath of majors, but evidence has suggested that students from different majors will have differing motivational mindsets when completing specific tasks (Mason & Bertram, 2018; Roebken, 2007). Further exploration into how specific majors respond to the reflection process could be an interesting avenue of inquiry. We would also suggest explorations as to whether these reflections helped students to develop their metacognition. In-depth interviews regarding students' experiences during the course could provide a rich understanding of how students perceived their use of the

technology and provide meaningful insight into how it helped them develop their skillset. Our work is a promising initial study that shows the importance of reflection scaffolding and provides a useful context for further explorations of the phenomenon.

Tables and Figures

Figure 1

Scaffolding feature in CourseMIRROR



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