AI Agent-based Scaffolding for Online Learners' Self-regulation

Donggil Song, Ph.D.
Instructional Systems Design and Technology
Sam Houston State University, Huntsville, TX, USA.
donggil.song@gmail.com

Background/Context

Although promoting students' self-regulated learning is imperative in online learning, it is challenging for learners to acquire self-regulation skills in a limited time frame. It is also demanding for an individual instructor to monitor each student's self-regulation process to provide appropriate scaffolds in a timely manner. However, few studies have systematically investigated how to scaffold students' self-regulated learning in online courses.

There has been a consensus that self-regulation knowledge and skills are teachable (Azevedo & Cromley, 2004; Zimmerman, 2002) and "scaffoldable" (Kramarski & Michalsky, 2009). There have been a few attempts to scaffold self-regulated learning in online learning environments (e.g., van den Boom, Paas, & van Merriënboer; 2007).

Online interaction is not only crucial for self-regulated learning scaffolding but also significant for learner participation. When providing interactive scaffolding for students, learner participation levels could be increased. It is difficult to expect a human tutor's or peers' unceasing presence for interactive scaffolding in regular distance education settings. To address this issue, researchers have utilized computerized, interactive, and intelligent systems. Given the effectiveness of interaction that an AI conversational system can provide, online learners might benefit from the interactive system if appropriately used.

Purpose/Objective/Research Question

The authors aim to investigate the effects of a conversational virtual agent in online courses, as a means to regularly engage them in synchronous dialogs designed and structured both to scaffold their self-regulated learning and to encourage learner participation. Research Questions are: (1) What are the effects of conversational agent-based interactive scaffolding on learners' self-regulation, course participation, and learning performance?; (2) Does learners' self-regulation influence learning performance in relation to course participation?

Setting, Population/Participants/Subjects, and Research Design

An experimental design with a two-group setting (i.e., an interactive scaffolding group and a control group) was applied. Fifty-six students who enrolled in four online graduate courses participated in this study. The participants were randomly assigned to one of two conditions: (1) scaffolding group (self-regulation scaffolding with a conversational agent was provided) and (2) control group (the information about self-regulation was provided through email).

Intervention/Program/Practice

Conversation with the agent was a required task in the courses. Once a week, 15 times during the semester, the conversational agent prompted with specific questions, the students replied back to the agent. A learner can have a conversation with the agent through text-based chatting. The prompts were adopted from the literature of self-regulated learning. The agent responds to the learners' answers and responses with the pre-planned scripts or scenarios.

Data Collection and Analysis

To measure students' self-regulation levels, the Motivated Strategies for Learning

Questionnaire (MSLQ) was used (Pintrich & DeGroot, 1990), which includes 44 items that measure learners' motivational orientations and their use of different learning strategies on a 7-point scale. To measure the students' course participation levels, LMS log data were collected. To assess students' learning performance, their final grades were used.

To determine the effect of interactive scaffolding, Hotelling's T^2 test was conducted for the difference in two multivariate means with the condition as an independent, MSLQ, course participation, and final grade as dependent variables. To determine whether self-regulation influenced learning outcomes through course participation, a mediation analysis was performed with the bootstrapping process for significance testing.

Findings/Results

The result shows that there was no difference between groups. To find the effect of interactive scaffolding on each of self-regulated learning, participation, and performance, independent *t*-tests were performed. There was a significant difference in the self-regulated learning scores for the interactive scaffolding and control conditions. However, there were no significant differences in the participation levels for the interactive scaffolding and control conditions; and in the learning performance scores for the interactive scaffolding and control conditions.

A single linear regression analysis was conducted to find the effect of self-regulated learning on learning performance, which shows a significant relationship between self-regulated learning and learning performance. Another single linear regression analysis was conducted to find the effect of self-regulated learning on learner participation, which shows a significant relationship between self-regulated learning and learner participation. Last, a multiple linear regression analysis was conducted to find the effect of self-regulated learning and learner participation on learning performance, which indicated that there was a collective significant effect between self-regulated learning, learner participation, and learning performance. The individual predictors were examined further and indicated that learner participation was a significant predictor in the model, but self-regulated learning was not a significant predictor in the model. Thus, it can be argued that a mediation effect exists; that is, the effect of self-regulated learning on learning performance goes through learner participation. To examine if this mediation effect is statistically significant, the bootstrapping process for significance testing was conducted. The result shows that the mediation effect is not statistically significant.

Conclusions

The results show that interactive scaffolding group's self-regulated learning levels were higher than the control group. However, the course participation and learning performance were not different between the two groups. The regression analyses showed the mediation relationship; that is, self-regulated learning can have an impact on learning performance through the mediation of course participation. The bootstrapping analysis shows that the mediation is not statistically significant. Some limitations to this study warrant consideration. First, the present data regarding self-regulated learning levels were self-reported; thus, they reflect individual learners' views and not their actual, observed learning behaviors. Second, the small size of the sample recruited from multiple courses might limit the results of this study.

References

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