

Does Feedback from ChatGPT help? Investigating the Effect of Feedback from both Teacher and ChatGPT on Students' Learning Outcomes

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Abstract

To facilitate learning in higher education, ChatGPT is generally used by students to seek immediate feedback on their school work. The synergic use of feedback from both traditional channel (i.e., teachers) and emerging GenAI (i.e., ChatGPT) has fundamentally changed the way students learn. In this study, based on cognitivism framework and self-regulated learning theory, a research model was developed to test the relationship between feedback (from both teacher and ChatGPT) and learning outcomes. Self-efficacy and affective engagement are important factors in cognitive learning theories, and are proposed to be mediators along the paths. Data are collected among students who took computing related subjects, and used ChatGPT in programming tasks. Based on data analysis with 300 students' records, feedback from both teacher and ChatGPT are proved to have significant effects on self-efficacy and affective learning, and the two mediators significantly influence learning outcomes.

Keywords

Feedback, ChatGPT, self-efficacy, affective engagement, learning outcomes.

Introduction

Providing educational feedback has been widely acknowledged as an effective pedagogical approach to improve student learning. Feedback is defined as information given to students on their performance that guides future study behavior (Ambrose, et al., 2010). It can be verbal or written, and may come from multiple sources/agents (peer, teacher, self, task itself, and computer) (Lipnevich and Panadero, 2021). A large amount of pedagogical research focused on the effectiveness of feedback from human teachers. However, recent years have witnessed a wide use of automated grading systems (Perikos, et al., 2017) or automated feedback systems (Marwan, et al., 2020) in various educational scenarios. This is largely due to the constraints of teacher resources providing timely feedback to the growing student population, and the advancement of information technologies. ChatGPT has transformed the way feedback is given. It can provide feedback that guides students toward a correct or desirable direction, and provide instant and personalized responses to learners. Due to the instant feedback, students could understand their mistakes or get guidance immediately. Moreover, compared with the traditional tutoring feedback system, ChatGPT is believed to be more intelligent, conversational, personalized, and detail-oriented

(Exance, 2023). As such, it becomes a powerful tool, alongside teachers, to provide effective feedback.

Teacher's feedback has been studied extensively to influence students' learning performance, however, the extant literature on the effectiveness of feedback from ChatGPT remains at the conceptual level (e.g., Dai, et al., 2023) or at an exploratory stage (e.g., Jacobsen and Weber, 2023). There is a lack of empirical research exploring the effectiveness of feedback, specifically the consequences of feedback from ChatGPT alone, and those from both teachers and ChatGPT. In the field of programming-related subjects, Kiesler et al. (2023) proved that ChatGPT performs reasonably well for programming tasks, and contains textual explanations of the causes of errors. In view of these, this study explores the consequences of feedback from both teachers and ChatGPT in programming-related subjects. Based on the cognitivism learning framework (Thurlings, et al., 2013) and self-regulated learning theory (Nicol and Macfarlane-Dick, 2006), we proposed a conceptual model that contains two mediators: self-efficacy and affective engagement. Self-efficacy, a key element in cognitive learning theory (Van Dinther, et al., 2011); and affective engagement, significant influencer of motivation to learn (Saeli and Cheng, 2021). These two constructs mediate the relationships between feedbacks and learning outcomes. The research questions are:

RQ1. Are there any significant effects of feedback from teachers and ChatGPT on students' self-efficacy and affective engagement in learning?

RQ2. Will students' self-efficacy and affective engagement mediate the relationship between two feedbacks and learning outcomes?

Theoretical Foundation

To understand feedback in a learning environment, we adopted the cognitivism learning framework (Thurlings, et al., 2013) and self-regulated learning theory (Nicol and Macfarlane-Dick, 2006). Cognitivism learning stresses human information processing. There is a cognitive learning process for students once feedback is received. The result of feedback is reflected in the learning outcomes (Figure 1). Self-regulated learning theory is developed on top of the cognitivism theory. It believes that feedback is a cognitive process to help students take control of their own learning, and thus become self-regulated learners. In higher education, feedback from any agent (i.e., teacher or ChatGPT) can be used to empower students to become self-regulated learners. As self-regulation theory is a process of guiding one's own thoughts, behaviors and feelings to reach goals, it is used to explain the relationship between both feedbacks and cognitive status (self-efficacy and affective engagement).

Hypotheses Development

The research model is shown in Figure 2.

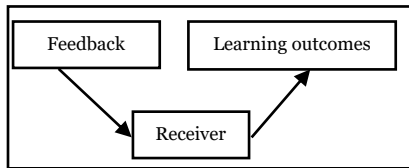


Figure 1. Cognitivism framework of feedback

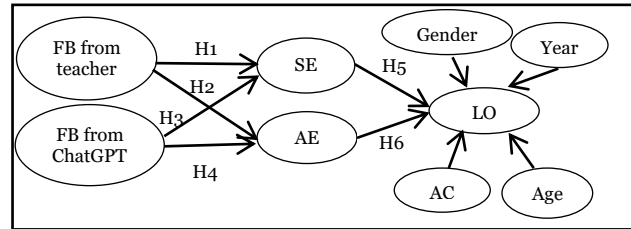


Figure 2. Research model

Notes: FB=Feedback; SE=Self-efficacy; AE=Affective Engagement; LO=Learning Outcomes; AC=Assessment Characteristics

Based on the self-regulated learning theory, external feedback can influence how students feel about themselves (Nicol and Macfarlane-Dick, 2006). Teachers' external feedback informs students' learning strategies, and thus influences self-efficacy (Zimmerman and Kitsantas, 2002).

H1: Feedback quality from teacher is positively related to students' self-efficacy

Affective engagement deals with people's emotional responses to learning. It includes learners' enthusiasm, interest, enjoyment, anxiety, and boredom (Philp and Duchesne, 2016). Based on the self-

regulated learning theory, the more self-regulated students will be more engaged with the coding tasks to reach their desired goals (Butler and Winne, 1995). Teachers' feedback plays a critical role in supporting students' affective involvement and motivation in learning (Zhang and Hyland, 2022).

H2: Feedback quality from teacher is positively related to students' affective engagement

Feedback from ChatGPT can help address programming problems immediately based on students' needs. ChatGPT is able to provide coding and debugging explanations, therefore, greatly improves students' self-efficacy (Yilmaz and Yilmaz, 2023). Moreover, from the perspective of self-regulated learning theory, self-regulated learners tend to plan and monitor themselves better by using ChatGPT and thus enhance self-efficacy (Chang et al., 2023).

H3: Feedback quality from ChatGPT is positively related to students' self-efficacy

Recent research indicates that technology intervention, represented by ChatGPT, can enhance students' affective engagement by providing help to overcome difficulties, reducing frustration, and providing dynamic and interesting interactive learning opportunities (Wu, et al., 2024).

H4: Feedback quality from ChatGPT is positively related students' affective engagement

Students' self-efficacy has a stronger effect on academic performance than other motivational beliefs (Pintrich and Schunk, 1996). Students with higher self-efficacy tend to be persistent, and often have effective ways to tackle problems in order to achieve their academic goals (Zajacova, et al., 2005).

H5: Students' self-efficacy is positively related to students' learning outcomes

While positive affective states contribute to the success of the study by improving students' attentiveness, negative affective states may impair learning by increasing their cognitive load (Grawemeyer, et al., 2017). Affective engagement is most effective in promoting learning outcomes and is a mental and emotional energy that fuels learning (Halverson and Graham, 2019).

H6: Students' affective engagement is positively related to students' learning outcomes

Similar to the literature in the same research context, assessment characteristics, age, gender and year are deemed control variables in relation to learning outcomes (Yilmaz and Yilmaz, 2023).

Research Methods

Measures and Data Collection

Measures were adopted from the past literature with minor adjustments to reflect the context of ChatGPT. For instance, feedback was measured by timeliness, accuracy, detailedness and more. We conducted a cross-sectional survey in a public university of Hong Kong. The participants are undergraduate students who have taken programming-related subjects in the past two years with the aid of ChatGPT. A total of 1000 questionnaires were sent out, with 410 valid responses. Among them, 300 answered "yes" when checking the use of ChatGPT.

Data Analysis

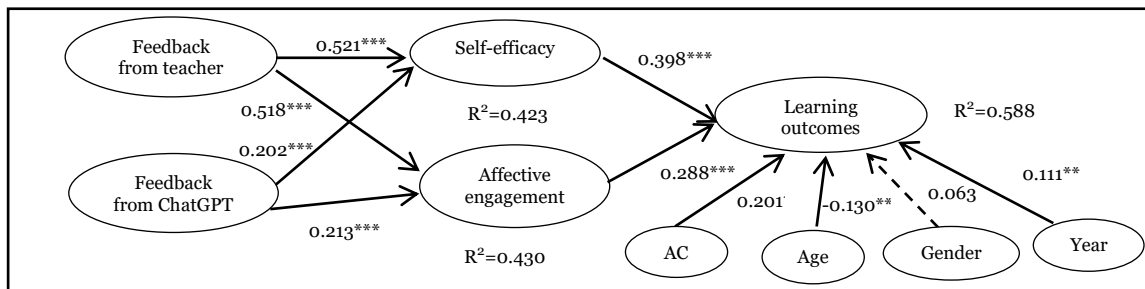


Figure 3. Structural model data analysis results

Notes: ** p < 0.05, *** p < 0.01; the solid lines were supported, while the dotted lines were not supported.

SPSS (v. 27) and SmartPLS (v. 4.1.0) (Ringle, et al., 2024) were used as the statistical software. SPSS was used for exploratory factor analysis, and the PLS-SEM algorithm was run to test the validities. The structural model was tested by the Bootstrapping approach of SmartPLS. Results in Figure 3. showed all main hypotheses were supported, and three out of four control variables showed significant effects on learning outcomes. The R square values of the two mediators are 0.423 and 0.430 respectively, and that of the dependent variable is 0.588. These results demonstrated a good explanatory power.

Discussions

First, we confirmed that teacher feedback quality is positively related to students' self-efficacy. This result is consistent with the past literature (Zimmerman and Kitsantas 2002) on using self-regulated learning theory to explain learning phenomena. Second, teachers' high-quality feedback will also lead to a higher affective engagement. This is in line with empirical studies such as Zhang and Hyland (2022) and self-regulated learning theory. Third, feedback from ChatGPT is confirmed to positively influence students' self-efficacy. Similar to teachers' feedback, ChatGPT's feedback also has a significant impact on self-efficacy. This is congruent with the past literature (i.e. Yilmaz and Yilmaz, 2023; Chang et al. 2023) and the major contribution of the study. Fourth, similarly, feedback from ChatGPT infers a higher level of students' affective engagement. This is consistent with Wu, et al. (2024) that ChatGPT can deliver dynamic and interesting learning opportunities, and therefore make learning more exciting and engaging. Fifth, students' self-efficacy and affective engagement positively lead to students' learning outcomes. Again, this result is congruent with the literature on students' engagement and learning (i.e., Grawemeyer, et al. 2017). Sixth, we further tested the synergy effect between two feedbacks in influencing learning outcomes, the direct interacting effect was significant. Seventh, the results shown a stronger effect from the feedback from teachers than that from ChatGPT (T values comparison). Last, it is reasonable to control assessment characteristics, age and year when examining the effects.

Implications and Limitations

The biggest theoretical implication is to apply self-regulated learning theory to explain the consequences of feedback. Second, our research is among the few empirical studies investigating the influence of ChatGPT, and to compare the effectiveness of feedback from traditional teachers and ChatGPT. Practically, university educators should seriously consider using ChatGPT as a supplementary tool, as it can help to enhance self-efficacy and affective engagement, and ultimately improve learning outcomes. The first limitation lies in the selection of the mediators. More interesting mediators should deserve further investigation (e.g., motivation, and other dimensions of engagement, etc.). Second, data on the dependent variable-learning outcomes could be collected at a different time to further avoid common-method bias. Third, our study focuses on students who took programming-related subjects, the responses from ChatGPT would be different from those generated for other subjects across multiple disciplinary areas (e.g., arts, multimedia, business). Cautions should be paid when generalizing the results to other areas of pedagogical studies.

Conclusions

ChatGPT has transformed the way students learn, and become a versatile tool to provide personalized support, direction, and feedback to autodidactic learners. This study employs self-regulated learning theory under the cognitivism framework to explain the consequences of feedback from both teachers and ChatGPT. The data analysis results confirmed positive relationships between feedback from both sources and students' cognitive processing status (self-efficacy and affective engagement), and the relationships between the mediators and learning outcomes. Our study is among the first to simultaneously investigate the effects of feedback from teachers and ChatGPT. It also inspires more pedagogical research to explore and compare the consequences of feedback both teachers and ChatGPT.

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