



Integration of Pedagogical Agent in Learning

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Abstract. Research found that the use of technology in teaching and learning is able to reduce mathematics anxiety by initiating students' motivation to explore and enjoy mathematics instead of feeling worries over it. There is a better human-computer interaction for student engagement and motivation in learning when using technology and pedagogical agent. This study aimed to investigate the effectiveness of integrating the pedagogical agent in mathematics learning. An experimental research approach was employed with the involvement of undergraduates at a university in Malaysia. Undergraduates' learning was via a system with the integration of a pedagogical agent who provided motivational type of messages in teaching Calculus. Mathematics Anxiety Rating Scale was employed to measure students' anxiety levels before and after the study. Before the study, students were grouped into high, medium and low mathematics anxiety levels. Prior to the study the sample consisted of a high number of medium math-anxious students. There was no significant difference in the mean score of anxiety level for high and low math-anxious students, respectively, but there was a significant difference in the mean score between pre- and post-tests for medium math-anxious students. This agreed with the sample of this study that majority of the students were medium math-anxious students. Thus, integrating the pedagogical agent in mathematics learning effectively decrease students' mathematics anxiety level particularly in Calculus. A better human-computer interaction for student engagement and motivation in learning was gained when pedagogical agent was integrated in learning, hence effectively reduce students' mathematics anxiety.

Keywords: Pedagogical agent · Mathematics anxiety

1 Introduction

Research found that the use of technology promotes students' active engagement in mathematical tasks. Moreover, it also provides great opportunity for peer interaction, instant feedback, and supports to students [1, 2]. As such, it is able to efficiently reduce mathematics anxiety by initiating students' motivation to explore mathematics and enjoy mathematics instead of feeling worries over it [3–5]. A positive and comfortable learning

atmosphere and environment is created through the integration of technology in mathematics learning in which students' anxiety and tension on the complexity of mathematics problems solving are reduced particularly when the pedagogical agent is integrated into the learning system.

Learning solely using technology may cause students feel isolated in the virtual learning environment, thus, a human like agent, i.e. pedagogical agent, can be integrated into the learning system to provide more human-computer interactions. With the integration of pedagogical agent into technology, there is a better human-computer interaction for students' engagement and motivation in learning. Furthermore, more students' engagement in learning with the agent in the learning system will enrich students' learning experiences which resulted in positive emotions in students. This is because learning mathematics in the virtual environment is an individual-based learning that lessens the possibility of embarrassment and stress when they are making learning errors as compared to the face-to-face learning with teachers in the classroom [6].

Most students have moderate level of anxiety in learning [7]. Research findings also showed that majority of Malaysia students have medium level of anxiety in mathematics [8–10]. In addition, it was found that mathematics anxiety among students increased when students were taught with traditional teaching methods [11]. According to Kapoor, in the traditional teaching classroom, teachers do not consider different learning styles among students and students' special needs, which increases students' anxiety towards mathematics. Furthermore, students are unable to obtain practical and in-depth knowledge. He stated that modern teaching methods should focus on students self-learning and self-expression [12].

Hence, in this study, a learning system with the incorporation of pedagogical agent was developed to allow students learn mathematics in the virtual environment at their own pace. The purpose of this study was to investigate the effectiveness of integrating the pedagogical agent in mathematics learning, particularly for students of different mathematics anxiety levels. The hypothesis of the study was that learning with the pedagogical agent effectively reduce students' mathematics anxiety level particularly in Calculus.

2 Methodology

The target population comprised undergraduates at a university in Malaysia. Their age ranged from 19 to 27 years old. An experimental research approach was adopted in this study for two months. The chosen topic for the study was Calculus.

A system with the integration of a pedagogical agent was developed for Calculus. Students' learning was via this system in which the pedagogical agent teaches Calculus. The pedagogical agent played three roles in this system as lecturer, tutor and motivator. All teaching materials delivery was delivered by the agent as a lecturer. The agent explained the Calculus concepts and examples. It also guided students' learning through explanation of working steps of Calculus tutorial questions as a tutor. During the problem-solving process, the agent motivated students by providing motivational works or messages if students encountered problems. With the aim to reduce students' anxiety, the pedagogical agent provided motivational type of messages in students' learning.

To measure students' anxiety levels before and after the study, Mathematics Anxiety Rating Scale was employed. The Mathematics Anxiety Rating Scale was a 7-likert scale instrument. Before the study, students were categorised into high, medium and low mathematics anxiety levels based on their scores in the pre-Mathematics Anxiety Rating Scale. The mean scores of both pre- and post-Mathematics Anxiety Rating Scale were tested at 5% significance level. The data was analyzed using SPSS.

The project was conducted in 3 phases: in the first phase, Mathematics Anxiety Rating Scale was given to students; in the second phase, students used the system with the integration of a pedagogical agent in their learning; in the last phase, Mathematics Anxiety Rating Scale was again given to students.

3 Findings

There were 43 undergraduate students participated in this study. Based on the pre-Mathematics Anxiety Rating Scale results, these 43 students were grouped into 5 low math anxious students, 31 medium anxious students and 1 high anxious student. In other words, before the study, the sample consisted of a high number of medium math anxious students.

Figure 1 shows that the mean score of Mathematics Anxiety Rating Scale for low math anxious students before the study was 3.039 and increased to 3.252 in the post-test. There was a decreased in the post-test mean score for both medium and high anxious students. For medium mathematics anxious students, their mean score of pre-test of 3.969 was reduced to 3.792 in the post-test, while high anxious student recorded a mean score of 5.258 in the pre-test but also decreased in the post-test with the score of 4.387.

At 5% significance level, the findings show significantly difference in the mean score between pre- and post-tests of anxiety level for medium math anxious students, whereas there was no significant difference in the mean score between the pre- and post-tests for high and low math-anxious students, respectively.

A detailed finding was shown in Table 1. There was only one student with high mathematics anxiety level before the study, hence, no comparison via *t*-test can be made. Table 1 shows that there was a significant difference between pre- and post-tests mean scores for medium math-anxious students, $p < 0.05$, but not for low math-anxious students, $p > 0.05$. Medium math-anxious students showed a significant decrease in mean scores in the post-test ($M = 3.792$, $SD = 0.612$) than in the pre-test ($M = 3.969$, $SD = 0.493$). Low math-anxious students, on the other hand, did not show a significant increase in mean scores in post-test ($M = 3.252$, $SD = 0.391$) from the pre-test ($M = 3.039$, $SD = 0.100$).

4 Discussion

The finding generated for students' prior mathematics anxiety levels found that majority of the students from this study were categorised as medium mathematics anxious students. This finding is not only in line with previous study that most students have

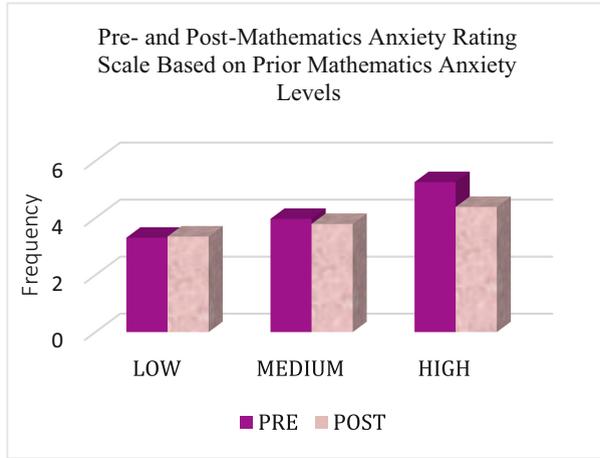


Fig. 1. Pre- and post-Mathematics Anxiety Rating Scale based on prior mathematics anxiety levels.

Table 1. Comparison of means between pre- and post-Mathematics Anxiety Rating Scale based on different prior mathematics anxiety levels.

| Anxiety Level | N | Test | Mean | SD | MD (SD) | <i>t</i> -value | df | <i>p</i> -value |
|---------------|----|------|-------|-------|----------|-----------------|----|--------------------|
| Low | 5 | Pre | 3.039 | 0.100 | -0.213 | -1.445 | 4 | 0.222 |
| | | Post | 3.252 | 0.391 | (-0.329) | | | |
| Medium | 37 | Pre | 3.969 | 0.493 | 0.177 | 2.761 | 36 | 0.009 ^a |
| | | Post | 3.792 | 0.612 | (0.390) | | | |
| High | 1 | Pre | 5.258 | - | - | - | - | - |
| | | Post | 4.387 | - | - | | | |

Note ^aSignificant at 5% significance level

moderate level of anxiety in learning [7] but also is in line with the results of previous studies [8–10] that majority of the students of Malaysia are medium math-anxious students.

Upon this finding, analysis is conducted in this study to compare the students' mathematics anxiety before and after study based on their prior mathematics anxiety levels. It was found that after learning with the pedagogical agent, students have less anxious towards mathematics. Although the mean score of Mathematics Anxiety Rating Scale for low mathematics anxious students increased in the post test, but it is not significant. However, after the study, the medium math-anxious students had shown a significant difference between the pre- and post-tests. They had significantly decreased their mathematics anxiety after the study. The medium math anxious students constituted 86% of

the sample size, thus the significant decreased in mathematics anxiety among them could represent the sample of this study that students showed less anxious towards mathematics after study.

Moreover, students opined that they were actively interacted with the pedagogical agent during the problems solving process. The pedagogical agent provided immediate feedback to them when they faced difficulty at certain solution steps and provided supports and motivation to them to complete the mathematics task. They also dared to explore more mathematics questions and have no fear towards the complexity of the mathematics problems solving process because the pedagogical agent guided them moving towards the correct answers, and encouragement and motivations were given by the agent even though they made errors. This showed that the use of learning system with the pedagogical agent promotes interaction, provides instant feedback, supports and motivation to students, as stated in previous studies too [1–5]. Furthermore, in this kind of atmosphere and environment, students felt no embarrassment to commit errors, less tension, anxious and stress towards learning mathematics. As such, a positive and comfortable learning atmosphere and environment was created which agreed with Jansen et al. [6].

5 Conclusion

Educators need to be aware of students' anxiety in learning, particularly in mathematics. They need to understand which anxiety level their students have. After understanding their students' anxiety level, educators should take into consideration of different anxiety levels among the students when prepare the teaching materials and adopt the appropriate teaching methods. Efforts should be made to reduce students' anxiety among students, particularly high anxious students, towards the subject. Thus, educators could consider to adopt modern teaching methods which focus on students self-learning and self-expression as suggested by Kapoor [12].

From this study, it can be concluded that learning with the pedagogical agent effectively reduce students' mathematics anxiety level particularly in Calculus. The learning system with the integration of pedagogical agent allowed students learn mathematics in the virtual environment at their own pace which promotes self-learning. Also, a positive learning atmosphere and environment has been created to students. Learning with the pedagogical agent has provided a better human-computer interaction for student engagement and motivation in learning, hence effectively reduced students' mathematics anxiety.

It is recommended to extend the research to other subjects and to a wider scope. Furthermore, since the design of the layout of the system was based on a web browser where students can learn on personal computers, thus it was not compatible for viewing on mobile devices with smaller screens. The improvement can be done on this area for future research.

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Authors' Contributions. TCK—data analysis, paper writing, paper submission.
 KHS—system development, instrument preparation, data collection.
 TCP—data analysis, paper writing, paper submission.
 CWP—supervision of system development.

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