A PROPOSED FRAMEWORK FOR REDUCING MATHEMATICS ANXIETY USING LEARNING AGENT

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ABSTRACT

The Trends in International Mathematics and Science Study (TIMSS) 2011 showed Malaysia’s ranking in mathematics fell from 20\textsuperscript{th} in 2007 to 26\textsuperscript{th} in 2011 and the average mathematics score fell from 474 in 2007 to 440 in 2011. Many studies also found that mathematics anxiety caused lower mathematics performance. This proposed study aimed to propose a framework for designing a learning agent that helps to reduce mathematics anxiety levels among students. The learning agent will provide anxiety treatment messages according to the students’ anxiety levels. Therefore, this study will also identify the appropriate amount and types of the anxiety treatment messages that are provided by the learning agent. This paper will present the proposal of the study that will be conducted with the above objectives. In this study, there will be two online questionnaires given to a convenient sample of 100 undergraduates who attend Probability and Statistics lectures. The online questionnaires are conducted before and after the students learned the lessons with the help of a learning agent in a learning system. They are to collect students’ anxiety levels before and after the learning with an agent as well as the data on the appropriate amount and types of the anxiety treatment messages. In the learning with the agent, the agent will provide encouragement to students based on their mathematics anxiety levels. The learning agent will also lead them to solve problems step by step in order to ensure that they fully understand the concept. It is hoped that this proposed study will be significant to academicians, researchers and system developers in producing a pedagogical agent in computer-based learning in order to reduce students’ mathematics anxiety.

JEL Classifications:
Keywords: Mathematics anxiety, Learning agent, Anxiety treatment messages

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1.0 INTRODUCTION

Mathematics is important in our daily activities as it provides us skills for problem solving, logical reasoning and ability to think. However, mathematics performance among Malaysians has been degraded in last few years. The Trends in International Mathematics and Science Study (TIMSS) 2011 showed that Malaysia’s ranking in mathematics fell from 20\textsuperscript{th} in 2007 to 26\textsuperscript{th} in 2011 and the average mathematics score fell from 474 in 2007 to 440 in 2011 (TIMSS 2011 International Results in Mathematics, 2013). Most studies aim to find ways to improve students’ mathematics achievement and instil positive attitudes as students face numerous difficulties in mathematics (Ciltas & Tartar, 2011; Tahira & Sadia, 2010). One such difficulty is the anxiety in mathematics (Gerardo, Elizabeth, Susan, & Sian, 2012).

Studies reported that anxiety caused the low performance in mathematics (Karimi & Venkatesan, 2009). The development of anxiety may tied to both social factors and a student’s own basic numerical and spatial competencies – where deficiencies may predispose students to pick up on negative environmental cues about mathematics (Maloney & Beilock, 2012). Mathematics anxiety is an emotional reaction to mathematics when one having an unpleasant or embarrassed past experience. The causes that affect students having mathematics anxiety are students may think that mathematics are being hard for them and decided to give up due to the bad experience towards mathematics and lack of lecturers’ teaching skills (Effandi, Normalizam, Nur Amalina, & Erlina, 2012).

According to Marzita (n.d.), when students face problems involving mathematics, they will start to have negative self-talk that they are poor in mathematics. The negative feelings such as fear, panic, worry and anxiety make students start to avoid facing mathematics and this will lead them unable to perform better in mathematics. Hence, they will think that they are poor in mathematics. Therefore, students should have positive self-talk
instead of negative self-talk as negative attitude is an obstacle that will prevent them from being successful. Positive self-talk such as “I will succeed in mathematics” or “I love mathematics” should be possessed by students. As such, students have confidence towards mathematics and have better performance in mathematics. In addition, lecturer’s personality and teaching style also causes mathematics anxiety exists among students. Lecturers blaming students for not understanding, strictness and fierceness towards students and show no interest in their students cause students fear of seeking helps when facing problem. Consequently, students have no interest in mathematics in long term.

Therefore, one should have a good learning experience in order to overcome the unpleasant experience. As such, one can successfully achieve better performance in mathematics. Maloney and Beilock (2012) found that students showed a marked increase in their Mathematics performance when anxiety is reduced. In computer-based learning environment, the strategy that could be adopted is to use a pedagogical agent to help students to relieve their anxiety towards mathematics. Studies showed that the anxiety treatment messages conveyed by a pedagogical agent helped students relieved mathematics anxiety and hence performed better in mathematics (Wei, 2010).

In mathematics learning, the pedagogical agent provides positive emotions to students and plays a critical motivational role as it interacts with students (Baylor, 2009). As such, students are motivated and engaged by the pedagogical agent in learning mathematics, and their self-ability in solving mathematics problems will also increase. The pedagogical agent assists students immediately by giving appropriate feedback when they are facing difficulties in solving mathematics problems as some students may not immediately ask questions to their lecturers on the problems they face (Cheng & Chen, 2012). Consequently, students’ anxiety towards mathematics problems decreased. Researchers found that students showed increased motivation and engagement through interactions with agents which in turn lead to improved learning and performance outcomes (Kim & Wei, 2011; Kramer & Bente, 2010).

It was found that most research studied the effects of using pedagogical agent in learning, but no study is done on examining vary amount of anxiety treatment messages that could be provided by a pedagogical agent according to students’ anxiety level, which is also one of the recommendation from Wei’s study (Wei, 2010). In addition, research on investigating the types of treatment messages (i.e. verbal or non-verbal) that could be provided by an agent according to students’ anxiety levels is limited. Therefore, a project on examining vary amount and types of anxiety treatment messages that could be provided by a pedagogical agent according to students’ anxiety level will be conducted by the authors. The project will be conducted in three phases: (1) to investigate amount and types of anxiety treatment messages that could be provided by a pedagogical agent according to students’ anxiety level and propose a framework, (2) to develop a learning agent that could provide vary amount and types of anxiety treatment messages according to students’ anxiety levels, and (3) to evaluate the effectiveness of using this agent. This paper will present the proposal of the first phase of the project. The objectives of the first phase of this study are:

1. To identify the appropriate amount and types of the anxiety treatment messages in a computer-based learning environment according to the undergraduates’ anxiety levels.
2. To design a learning agent framework based on undergraduates’ anxiety levels.

2.0 METHODOLOGY

This section presents the proposed methodology of the first phase of the project.

2.1 Sample

A convenient sample of 100 undergraduates who attend probability and statistics course at a private university in Malaysia will be randomly selected for the study. It may consist of female and male students whose age ranged from 20 to 30 years old. Since Malaysia is a multiracial and multicultural country, the sample may comprise multi-races, i.e. Chinese, Malays, Indians, and others. Students from other countries such as Saudi Arabia, Indonesia, Iran, etc. may be included as well as there are international students study in this university.

2.2 Instruments and Mathematics Lessons

There will be two sets of online questionnaires used in this phase. The first set of online questionnaire, i.e. Mathematics Anxiety Rating Scale, will be used to collect data on students’ anxiety levels. It serves as a pre-survey questionnaire. It consists of questions that are adapted from McAnallen (2010), Klinger ((2006) and Wei (2010) and with some self-designed questions. There are 2 sections (Sections A and B):
Section A: This section is to collect students’ general information such as gender, age, nationality, race, majoring program and etc.

Section B: This section consists of mathematics anxiety rating scale that will determine students’ mathematics anxiety level. The likert scale ranging from Strongly Disagree (1) to Strongly Agree (5) for the items such as “I feel anxious when thinking of going to attend probability and statistics subject class.”, “Probability is a hard subject and only those who are smarter are able to understand.”, etc.

The second set of online questionnaire serves as a post-survey questionnaire. Data on the vary amount and types of the anxiety treatment messages that could be provided by the learning agent in a computer-based learning environment according to the undergraduates’ anxiety levels will be collected from this online questionnaire. It continued from the first set of online questionnaire, i.e. Section C, which consists of items such as “I would prefer more messages provided by the pedagogical agent in order to reduce my anxiety level in probability learning.”, “I prefer that the pedagogical agent provides me TEXT messages ONLY (no voice messages) to reduce my anxious in learning probability.”, “I prefer that the pedagogical agent provides me BOTH text and voice messages to reduce my anxious in learning probability.”, etc. The likert scale ranging from Strongly Disagree (1) to Strongly Agree (5) is used to respond to the questions in this section. In addition, the suggestions/comments column is provided for students to express their opinions, suggestions and comments regarding the amount and types of the anxiety treatment messages that could be provided by the learning agent in a computer-based learning environment.

Probability and statistics syllabus is chosen for the lessons that to be learned by students through online. Besides the teaching materials, the tutorials questions are to be included as well.

The questionnaires and the system (see 2.3) will be piloted. The pilot study is essential as it will help the researchers to obtain comments on the area which is overlooked and help to improve the instruments.

2.3 Research Procedure

It is proposed that at the initial stage of this phase, the Probability and statistics lessons and anxiety treatment messages will be designed and two sets of questionnaires will be prepared. At the time of preparing this paper, the first set of questionnaires had been designed. It has been piloted.

A learning system and learning agents (or pedagogical agents) will be designed in this phase as well. There will be three main parts in the system. In the system, students will respond to the pre-survey questionnaire (the first part of the system) to collect students’ anxiety level. Then they will be directed to the probability and statistics lessons (the second part of the system) in which the learning agent acts as the lecturer and tutor as well motivator in providing mathematics anxiety treatment messages. This is to expose students with the learning agent as they have never been exposing to the pedagogical agent during their study. Therefore, after they knew what is a pedagogical agent or learning agent, they will be able to respond to the post-survey questionnaire (the last part of the system) on collecting the data on the vary amount and types of anxiety treatment messages that could be provided by the learning agent.

In the learning, students will learn probability and statistics with the guidance of mathematics learning agents in a computer based environment. The learning agent as a lecturer will deliver teaching materials to students. As a tutor, the agent will assist students when they are facing mathematical problems and guide them the strategy to solve the mathematical problems. The agent will also act as the motivator by providing suitable anxiety treatment messages in terms of encouragement and support such as “Don’t worry. You will be able to solve this question. . . .”, “Well done.”. Finally, you have completed the task.” and etc. in order to boost students’ confidence level in solving mathematical problems.

At the end of the study, the data will be analysed using SPSS. Descriptive statistics, t-test, correlation and ANOVA will be performed to obtain results for the following hypotheses:

H1: There is significant relationship between the student’s anxiety levels and the amount of the anxiety treatment messages needed.

H2: There are significant differences in mean scores in students’ preferences of the types of anxiety treatment messages among the high anxious, medium anxious and low anxious students.

2.4 Method to Determine Students’ Mathematics Anxiety Level

Data on students’ anxiety level will be obtained using the pre-survey online questionnaire of Mathematics Anxiety Rating Scale. Students’ anxiety levels will be categorised into three levels which are low, medium and high. Using SPSS, the data collected from the questionnaire will be analysed for the mean score and standard
deviation in which these measures will be used to determine the anxiety levels for the students. Students will be categorised as having low, medium and high anxiety towards mathematics if they obtain score below one standard deviation from the mean value, within one standard deviation from the mean value, or above one standard deviation from the mean value, respectively.

3.0 PROPOSED FRAMEWORK FOR A MATHEMATICS LEARNING AGENT

This section discusses the proposed framework for a Mathematics Learning Agent in the first phase of the project.

FIGURE 1. PROPOSED MATHEMATICS LEARNING AGENT FRAMEWORK
The proposed framework (Figure 1) illustrates that the interaction between the learning agent and students exists in the computer-based learning environment. The interaction is through verbal and non-verbal messages. It is expected that the students of high anxiety level may need high number of anxiety treatment messages ($X$ amount) provided by the learning agent, while students of medium anxiety level may need moderate number of anxiety treatment messages ($Y$ amount) and low anxious students may need low number of anxiety treatment messages ($Z$ amount). $X$, $Y$ and $Z$ amount of anxiety treatment messages will be determined from the data collected from the post-questionnaire. In addition, the preferences of types of anxiety treatment messages may differ among students of different levels of anxiety. Findings of the preferences of types of anxiety treatment messages will be obtained from the post-questionnaire as well. Students of high (or medium or low) anxiety level may prefer the learning agent to provide information or messages through only verbal or only non-verbal or both at the same time compared to their counterparts. Therefore, with this proposed framework, more advance agents could be designed and developed to tailor to the needs of students of different anxiety levels in order to help them to reduce their anxiety towards learning mathematics and thus achieve better performance. This will be done in second phase of the project.

4.0 RESULTS

The first set of online questionnaire was piloted to 36 undergraduate and the data was analysed using SPSS. The questionnaire has a reliability value of 0.75. The piloted sample’s age ranged from 21 to 28 years old (Figure 2). It was found that majority of the students are 22 years old, i.e. 14 students (38.9%), followed by 8 students (22.2%) whose age are 24 years old. In addition, there was no student whose age is 27 years old. Majority of the students are males (33 students, 91.7%) (Figure 3). The sample consists of 27 Malaysians (75%) and 9 international students (Figure 4).

FIGURE 2. AGES OF THE SAMPLE
FIGURE 3. GENDER OF THE SAMPLE
FIGURE 4. NATIONALITY OF THE SAMPLE
As shown in Figure 5, there were equal number of students (16 students, 44.4%) from Security Technology program and Data Communication and Networking program, while only 4 students (11.1%) from Information Technology Management program.

FIGURE 5. COURSES OF THE SAMPLE
To determine the students’ mathematics anxiety level, the overall mean value and standard deviation were calculated from the data obtained from Section B of the pre-questionnaire. The data for this sample produced a mean value of 2.96 and the standard deviation of 0.22. Therefore, students who obtained scores below 2.74 are at low anxiety level, within 2.74 to 3.18 are at average anxiety level, and above 3.18 are categorised as high anxious students. Based on this, it was found that out of 36 students, there were 27 students, 6 students, and 3 students are at high, average and low anxiety levels, respectively.

Once the system with the learning agent and the post-questionnaire are designed, they will be piloted to the same sample too. Finally, results and comments from pre and post-questionnaire as well as the system with the learning agent are to be considered for the improvement of the instruments and the system.

5.0 CONCLUSION

In concluding, while previous research has showed learning mathematics with a pedagogical agent benefited students, this study contributed to the design and development of pedagogical agents which provide vary amount and types of anxiety treatment messages according to students’ anxiety level. Among the implications of this project include students improved interest in learning, improved in mathematics performance and reduced in mathematics anxiety. Therefore, this project which is focusing on learning agent and providing mathematics anxiety treatment messages can motivate students’ learning by reducing students’ anxiety level towards learning probability and statistics. In summary, the first phase of project is to help researchers to identify the appropriate amount, types of anxiety treatment messages and matching for students in different anxiety levels, i.e. high, medium and low. It is hoped that, after the framework is designed in the first phase of this project, the second phase will be successfully implemented, in which-learning agents are designed to provide appropriate amount of anxiety treatment messages that suit to the needs of the high, medium and low anxious students. As such, the anxiety level of students could be reduced and confidence level will be increased further. In addition, this proposed study is also significant to academicians, researchers and system developers in producing a suitable learning agent with the proposed amount and types of anxiety messages in computer-based learning in order to reduce students’ mathematics anxiety.

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