A Structural Equation Model of Persuasive Features for Computer-Based Mathematics Learning

Baharuddin Aris¹, Alireza Gharbaghi², Maizah Hura Ahmad³ and Mohd Shafie Rosli⁴

¹,²,⁴Department of Educational Science, Mathematics and Creative Multimedia Faculty of Education, Universiti Teknologi Malaysia 81310 UTM Skudai, Johor, Malaysia

³Department of Mathematical Sciences, Faculty of Science Universiti Teknologi Malaysia 81310 UTM Skudai, Johor, Malaysia

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Abstract

In this paper, the features of a persuasive model for computer-based mathematics learning are identified. Content analysis was used to extract principles from the persuasive models, theories and approaches in the literature. Based on these principles, a questionnaire was designed and distributed among students from eight schools. Using structural equation modeling, 16 features classified as a tool, a presenter or an assessor are identified to be the important features that should be considered in developing a courseware to persuade students in the computer-based mathematics learning.

Keywords: persuasive model, content analysis, confirmatory factor analysis, structure equation model

1 Introduction

Learning and training mathematics have always been a challenge in education [1][2]. This is because failing to solve mathematics problems will affect perform-
The conception, attitude and expectation of students regarding mathematics are some important factors underlying experience and achievement in mathematics [4]. Some students believe that being good in mathematics is an inherited ability. But studies have shown that the most successful students are those who work the hardest. It is important to instill positive attitude regarding mathematics among students from their primary school years.

The literature has identified that success in mathematics depends upon attitude towards it. Some researchers believed that persuasion is a process of changing attitude and it is an educational approach. The technique of influencing is one of the essential skills that should be possessed by teachers and trainers as it enables them to help others in developing their skills and abilities [5].

Persuasion is a process that needs a specific plan [6]. There are several persuasive models and theories that are classified based on the different ways to shape, reinforce or change an attitude. One of the model is computer-based where captology is the first theory introduced in this area. Captology is the structure that focuses on the design, research and analysis of interactive computing products created to change attitudes or behavior [7].

Computers can be used to enrich mathematics teaching. This technology is a potential tool for students with learning disabilities to improve their learning [8]. Thus, the purpose of the current study is to determine features that could be incorporated in a mathematics courseware that would be able to persuade students to learn mathematics.

The rest of the paper is organized as follows. Sections two and three present the research methodology and research findings respectively. The conclusion is made in section four.

2 Research Methodology

For the purpose of this study, the features that can persuade learners to learn mathematics in a computer-based mathematics learning are investigated. Figure 1 illustrates the research framework of the current study.
The method used to collect the data was content analysis. This method consists of nine steps: theory and rational; conceptualization; operationalization; coding; sampling; training and pilot reliability; coding, final reliability; tabulation and reporting. A list of principles for designing a pilot questionnaire was prepared based on principles of persuasion and principles of persuasive models, approaches and theories from the literature. The questionnaire was validated by experts and distributed as a pilot study. The validity and reliability of the questionnaire was measured and the questionnaire was distributed among the respondents of the study. Confirmatory Factor Analysis was used to investigate the relationships between the variables in the study [10]. The conceptual framework was later drawn from structural equation modelling (SEM) approach using a statistical software package called Lisrel.

Several statistical measures were used to evaluate the model. Factor loading is one of the important indexes. The maximum score of this index is equal 1.00 and the score of more than 0.6 is good. The scores between 0.3 and 0.6 are acceptable. The minimum significant factor loading is 0.30 [11]. But to some researchers, factor loading of 0.25 is the cut-off point and less than 0.25 is set to zero [12]. Other fit-indexes considered are GFI (goodness of fit index) and AGFI (adjusted goodness of fit index). A value of more than 0.9 of 1 indicates a good fit. The relative chi-square is the value of the chi-square index divided by the
degrees of freedom (df). The criterion for acceptance varies across researchers, ranging from less than 2 [13] to less than 5 [14]. The RMSEA (root mean square error of approximation) index is constructed based on the model’s errors. The acceptable value for this error is between 0.05 and 0.08. A value of more than 0.1 is considered low and unacceptable [15].

3 Research Findings

In the current study, the principles of persuasion are based on Perloff [9] who defined persuasion as a symbolic process in which communicators try to convince other people to change their attitudes or behavior regarding an issue through the transmission of a message in an atmosphere of free choices.

In the literature, 13 different persuasive models in seven categories were identified. Sixteen principles and concepts of persuasion for using in computer-based learning environment were coded with the reliability index of 0.896. The sixteen principles/concepts/codes were further classified as a tool, a presenter or an assessor with the following definitions:

As a tool – codes that operate like a tool for persuading learners through voice, shape, colour, etc

As a presenter – codes that operate like a presenter/teacher by considering emotions, needs etc.

As an assessor – codes that operate like an assessor by providing rewards, reducing punishment etc.

Table 1 lists the final coding results with a brief description of each code, all with the purpose of being effective in persuading learners.

Table 1 Coded Principles and Concepts

<table>
<thead>
<tr>
<th>Code No</th>
<th>Brief Code Description</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>Transmission of messages by employing rational steps and processes</td>
<td>Presenter</td>
</tr>
<tr>
<td>Q2</td>
<td>Contents which are presented to increase knowledge</td>
<td>Presenter</td>
</tr>
<tr>
<td>Q3</td>
<td>Attending to learner’s emotion, empathy and compassion</td>
<td>Presenter</td>
</tr>
<tr>
<td>Q4</td>
<td>Give rewards and remove unpleasant contents based on learner’s performance</td>
<td>Presenter</td>
</tr>
<tr>
<td>Q5</td>
<td>Ability to produce social roles based on social norms</td>
<td>Presenter</td>
</tr>
<tr>
<td>Q6</td>
<td>Attending to learner’s attitude and beliefs</td>
<td>Tool</td>
</tr>
<tr>
<td>Q7</td>
<td>Providing an interactive condition by language cues etc</td>
<td>Presenter</td>
</tr>
<tr>
<td>Q8</td>
<td>Physical cues shown on display</td>
<td>Tool</td>
</tr>
<tr>
<td>Q9</td>
<td>Ability to personalize the display and courseware</td>
<td>Tool</td>
</tr>
<tr>
<td>Q10</td>
<td>Providing opportunities for self-assessment</td>
<td>Tool</td>
</tr>
<tr>
<td>Q11</td>
<td>Presenting new contents based on needs and problems</td>
<td>Presenter</td>
</tr>
</tbody>
</table>
A Likert scaled questionnaire based on the identified 16 codes was designed. The questionnaire was validated by using face validity and content validity. The reliability was measured using Cronbach’s Alpha method with a value of 0.790. A total of 379 students from eight schools participated in answering the questionnaire.

In our conceptual model, there are three unobserved (latent) variables, each comprises of several constructs. Figure 2 and Figure 3 illustrate the Lisrel diagrams for tool and presenter variables respectively.

**Figure 2: Latent Variable - Tool**
The factor loadings for assessor with constructs “Explaining the necessity of presented content” and “Provide opportunities that allows personal creativities and innovations are 0.84 and 0.95 respectively.

Table 2 list various fit indexes for all three latent variables.

<table>
<thead>
<tr>
<th>Index</th>
<th>Tool</th>
<th>Presenter</th>
<th>Assessor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi square/df</td>
<td>1.304</td>
<td>3.541</td>
<td>4.32</td>
</tr>
<tr>
<td>RMSEA</td>
<td>0.028</td>
<td>0.082</td>
<td>0.012</td>
</tr>
<tr>
<td>GFI</td>
<td>0.99</td>
<td>0.96</td>
<td>0.92</td>
</tr>
<tr>
<td>AFGI</td>
<td>0.98</td>
<td>0.92</td>
<td>0.94</td>
</tr>
</tbody>
</table>

4 Conclusion

The values of fit indexes in Table 4 are all within acceptable range as suggested in the literature. The current study thus proposes that a persuasive model for computer-based mathematics learning should include features that reflect computer as a tool, a presenter and an assessor as illustrated in Figure 4.

As a tool, the model includes the facilities and conditions that help the process of persuasion by the way of simplifying the job. As a presenter, it deals with issues regarding capacity of the computer to present the materials and different ways of presentations. As a computer, the model provides assessment activities to evaluate a learner’s achievement and performance.
Figure 4: A Persuasive Model for Computer-Based Mathematics Learning

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References


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