

A Check List for Evaluating Persuasive Features of Mathematics Courseware

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Abstract

The main propose of this study is to introduce a check list for evaluating persuasive features of mathematics courseware. Since, mathematics is a source of anxiety among students (Zeidner & Matthews, 2010), this research is an attempt to employ persuasive features that can be used in mathematics courseware. Specifically, we sought to determine criteria that are important for persuading learners; and to ascertain persuasive factors have this ability that employed in computer based mathematics learning. These features originated 13 different prior persuasive models, theories, and approaches that are categorized in seven groups. Content Analysis was used to extract 16 features. For reporting results of Content Analysis method, were conducted 9 research steps. In the next step, the check list was prepared by using extracted persuasive principals with 16 criteria. So, three of more popular mathematics courseware in Iran, were evaluated by new designed check list; and are reported the results. The results have shown the most popular mathematics courseware which its name is “Kusha & Misha”, could only earned approximately half of check list points. Two others courseware only be able to obtain a third of persuasive points. Totally, it can be concluded that, with more regard to the persuasion, perhaps we can overcome on negative attitudes toward mathematics in school students.

Keywords: negative attitude toward mathematics, check list, persuasion, persuasive technology

1. Introduction

In the recent years, a large number of tasks, duties and roles have been given to computers. Today, we can see them in variety roles as persuaders, including influencing roles that usually were filled by teachers, coaches, clergies, doctors, and sellers, among others. In fact, we have entered an era of persuasive technology. persuasive technology is a new version of persuasive theories and models where changing attitudes or behaviors of people (Perloff, 2010). It should be noted that we are still in the early stages of persuasive technology development whereas the potential of such technology is enormous (Fogg, 2003). Hence, persuasive technology is as an example of technological apparatus, have entered in various aspects of educational issues, learning processes, and classroom activities. According to Perloff (2010) definition, persuasion is 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. At a glance, it seems two main factors in this process are including: trying to change receiver/s attitudes or behavior and transmission of a message in an atmosphere of free choices.

Over the last decades, investigators in various filed of education have recognized a variety of students attitude toward different subjects, specially mathematics (Aiken, 1970; Gunderson, Ramirez, Levine, & Beilock, 2012; Hong, 2010; Hossain & Quinn, 2013; Lim & Chapman, 2013; Pilli & Aksu, 2012; Silverman & Subramaniam, 1999; Wong & Chen, 2012; Zakaria, Chin, & Daud, 2010). Mathematical skills are needed for managing even ordinary human relations (Ernest, Greer, & Sriraman, 2009; Kail & Cavanaugh, 2012). However, academic failure is one of the main problems in the educational systems especially in mathematics (Connor, 2012; Wendling & Mather, 2008; Zeidner & Matthews, 2010). Thus, In spite of increasing mathematics training plans,

methods, and strategies, the outcome is less satisfactory. Because, previous studies have shown, students' achievement in mathematics is affected by several factors such as the environment of the school, which must be favorable (Creemers & Reezigt, 2005), teaching and learning process (Tall, 1993; Van de Grift & Houtveen, 2006), gender differences (Stipek & Gralinski, 1991) school programs (Beghetto, 2010) and so forth. Also, the conceptions, attitudes, and expectations of the students regarding mathematics and mathematics teaching have been considered as very significant factor underlying their school experience and achievement (Borasi, 1996; Dogan, 2012; Reed, Drijvers, & Kirschner, 2010; Schoenfeld, 1985). Yet the subject of mathematics, although revered, remains a source of anxiety and trepidation for a large number of students (Zeidner & Matthews, 2010). Therefore, it seems positive attitude towards mathematics can leads students towards success in this subject. Hence, attempt to improve attitude towards mathematics at lower level provides a base for higher studies in mathematics.

Nowadays, several capabilities have been recognized in computer-based learning (CBL) environments. However, there are two critical drawbacks about them. First, the lack of the instructor; second the absence of motivation. These drawbacks seem to be reason for drop-out in CBLs (Yamada, 2009). The lack of the instructor may result in two problems. First, reduction of learners' consciousness regarding the necessity of study, as the learners feels no necessity to attend classroom. They have the chance to give priority to their personal affairs, which may lead to failure in the course (Bersin, 2004). Second, is feedback; in absence of an instructor, a reduction in appropriate and immediate feedback is expected (Bulter & Winne, 1995; Lou, Dedic, & Rosenfield, 2003). Thus, a system that supports learning consciousness is essential when no instructor is available in the learning environment.

Totally, it seems that to focus on persuasion and related matters in CBLs can be a solution to overcome mentioned problems. According to Pierce and Stacey (2004) findings, students with positive attitudes towards mathematics and mathematical computer tools overcome initial difficulties when using such a tool and progressed to more effective behaviors, such as using the tool to explore and develop their conceptual understanding. Moreover, differences between learners such as learners' differences in earlier knowledge, abilities, skills, and differences in affective variables (such as motivation) have an important role in the development of supportive learning environments (Vandewaetere, Desmet, & Clarebout, 2011). Thus, the main purpose of this study is to introduce a check list for evaluating persuasive features of mathematics courseware. Previous studies have shown high attitude toward a specific subject or matter in schools is a helpful factor to high achievement (McCoach & Siegle, 2001; Sankofa, Hurley, Allen, & Boykin, 2005). Since, there is no check list and no criterion to evaluate the ability of mathematics courseware to persuading students, this study is introduced an applicable check list for gaining this aim. So, at the first step, 13 different persuasive models, theories, and models in seven groups reviewed (Cameron, 2009; Fogg, 2003); and their principals were extracted. The extracted principals were a base to design the check list. In the next steps, validity and reliability of the check list were examined. The research process in the next sections will be illustrated.

2. Method

In this study Content Analysis was used to collect data. Briefly, Content Analysis is defined as the systematic, objective, quantitative analysis of message characteristics. It includes careful examination of human interactions (Neuendorf, 2002). He explains this method is included nine consecutive steps which they are Theory and Rationale, Conceptualization, Operationalization, Coding, Sampling, Training and pilot reliability, Coding, Final reliability, Tabulation and reporting. Based on final codes, the checklist prepared. This checklist included 16 criteria for evaluating persuasive features of mathematics courseware. Last step in this part of study was checklist validity.

3. Results

At the first step of Content Analysis method, the history of persuasive models, theories, and approaches reviewed. The principals of 13 prior persuasive models, theories, and approaches in seven groups are extracted. The results of this extraction are shown in Table 1 . These principals are categorized based on their origin models, theories, and approaches.

Table 1. Operating principles and concepts of persuasion models, theories and approaches

Categories of Models, Theories and approaches	Models Names	principles and concepts of persuasion
Message Effects Model	Yale Model (Hovland, Janis, & Kelley, 1953)	Need to a clear message, presenting message in a new way, assent of message by recipient
Attitude Behavior Approaches	Theory of Reasoned Action (Fishbein & Ajzen, 1975) Theory of Planned Behavior (Ajzen & Sozialforschung, 2000) Triandis Model of Interpersonal Behavior (Triandis, 1989)	Attention to recipients' attitude and believes, to create new motivations, present new concepts and knowledge, attention to social norms
Cognitive Processing Theories and Models	Elaboration Likelihood Model (Petty & Cacioppo, 1986) Heuristic-Systematic Model (Chaiken & Trope, 1999) Social Judgment Theory (Sherif, Sherif, & Neber-gall, 1965)	Increase the knowledge, creativity and innovation in the presentation, possibility to change in the conditions, using past knowledge, fixing defects and solving problems, to create testing ability
Consistency Theories	Balance Theory (Heider, 1982) Cognitive Dissonance Theory (Festinger, 1957) Probabilogical Models (W. McGuire, 1981)	Attitudes towards subject, attitudes towards presenter, possibility to change in forming elements, present new knowledge, presenting importance of subject, Presenting logical deduction, concluding based on reasons
Inoculation Theory	Inoculation Theory (W. J. McGuire, 1964)	Presenting logical reasons for new issues, presenting in the appropriate conditions
Functional Approaches	Functional Approaches (Katz, 1960; Smith, Bruner, & White, 1956)	Presenting usefulness reasons, giving reward, removing punishment
Computer Based Approaches	Captology Theory (Fogg, 2003)	Reducing complexity, attention to tunneling, providing new information relevant to individuals, possibility of personalization, Presenting in the appropriate conditions, possibility of self-evaluation, giving reward, possibility of simulation situations, physical cues, psychological cues, language cues, social dynamics cues, social role cues

The extracted principals were coding based on their relationships. In fact, this coding process was conducted for categorizing principals. The results of coding step, is shown in the Table 2.

Table 2. First coding step

No.	Combined Principles and Concepts	Frequency
1	Exist of a clear message, assent of message by recipient, Presenting logical deduction, concluding based on reasons, presenting usefulness reasons, Reducing complexity	6
2	Presenting message in a new process, increase the knowledge, presenting logical reasons for new issues, present new concepts and knowledge, present new knowledge, providing new information relevant to individuals	6
3	Attention to psychological cues, presenting in the appropriate conditions, presenting in the special conditions, to create new motivations	4
4	Giving reward, removing punishment, giving reward	3
5	Attention to social norms, attitudes towards presenter, social role cues	3
6	Attention to recipients' attitude and believes, attitudes towards subject	2
7	To apply language cues, social dynamics cues	2
8	Possibility to change in forming elements, changes in physical cues,	2
9	Possibility to change in the conditions, possibility of personalization,	2
10	possibility of self-evaluation, to create testing ability	2
11	Fixing defects and problems	1
12	Possibility of simulation of conditions	1
13	Presenting importance of subject	1
14	Using past knowledge	1
15	Attention to tunneling process	1
16	Creativity and innovation in the presentation	1
Total Frequency		38

In the next step of research, all 13 prior models, theories and approaches were selected as research sample. Training and pilot reliability was next step of Content Analysis method. To conduct this step, three researchers reviewed the extracted codes together in a meeting discussion. These colleagues were two PH.D students and researcher who were studying in education field. After a discussion on extracted principles, they could agree on the coding of variables. Then, in an independent coding test note the reliability on each variable. At each stage, the codebook or coding form were discussed and revised if needed. Next part was final coding; to conduct this stage of research, the investigator was prepared a codebook based on combined persuasive principles. This codebook was contained 16 different codes which they were originated of 38 principles. In fact, these 16 codes were resulted from to integrate previous models, theories, and approaches principles. Table 3 shows the results of this coding; it should be noted, these codes are prepared for using in computer-based learning environments.

Table 3. Final coding results

Code No.	Codes' Description
1	To transmission of messages, by employing rational steps and processes are effective to persuade learners.
2	The contents which are presented to increase the learners' knowledge are effective for persuading them.
3	Attending to learners' emotion, empathy and compassion can be effective on persuade them in the learning process.
4	Giving reward and to remove unpleasant contents during learning process to learner based on their performance can be effective in persuading learners.
5	Ability to produce the social roles based on social norms can be effective to persuade learners.
6	Attending to learners' attitudes and beliefs can be effective in persuading them to learn.
7	Providing an interactive condition in the learning process by languages cues, conversations and etc. are effect to persuade learners.
8	The physical cues that are shown on display can be effective to persuade the learners (i.e. faces, colors, movements).
9	Ability to personalize the display and courseware based on personal interests can be effective in persuading learners.
10	Providing opportunities for self-assessment by learner during the learning process can be effective in persuading learners.
11	Presenting new contents based on learner needs and problems can be effective in persuading learners.
12	Providing conditions to learners for working in simulated conditions by computer can be effective to persuade learners.
13	Explaining the necessity of presented content can be effective in persuading learners.
14	Consistency of new knowledge and messages with previous knowledge can be effective in persuading learners.
15	To provide the conditions that to guide learners into the learning tunnel can be effective to persuade learners.
16	Providing opportunities in the learning process to enable the learners to access personal creativities and innovations can be effective in persuading learners.

According to these Content Analysis steps, for measuring reliability, of this coding process William Scott formula was used. Based on this formula, 20 percent of models, theories and approaches are given to three researcher (Scott, 1955). After to conduct this step, results reported as follow (See Table 4).

Table 4. Coding reliability

Researchers	Percentage of Similarity
Researcher 1	% 90
Researcher 2	% 85
Researcher 3	% 94
Reliability	$\alpha = .896$

Based on final codes, the checklist prepared. This checklist included 16 criteria for evaluating persuasive features of mathematics courseware. Last step in this part of study was checklist validity. For doing this part of study, six experts who have had expertise in mathematics education and designing educational software are chosen. Then, the new designed check list was sent to them for collecting their viewpoints about it. Table 5. shows the selected experts in specification, educational filed, proficiency, and etc.

Table 5. Experts details

Name	Gender	Degree	Educational Filed	Proficiency
M. E.	Male	Master	Educational technology	Designing math courseware
S. KH.	Female	Master	Educational curriculum	Mathematics teaching method
Z. H.	Female	Ph.D.	Teaching mathematics	Mathematics teaching method
H. M.	Male	Ph.D.	Educational technology	Designing math courseware
S. R.	Male	Master	Software engineering	Designing math courseware
A. N.	Female	Ph.D.	Teaching mathematics	Mathematics teaching method

In this part of study, firstly, the designed check list was sent by a letter to experts. The letter is contained a brief explanation about designing mentioned. Secondly, the experts invited for a discussion meeting after 10 days. In this meeting, each expert explained its own viewpoints to others about contains of checklist. Finally, after the discussion meeting with experts some criteria were crystalized in the sentences and content for better understanding by users. Thus, last version of check list was finalized (see Table 6).

Table 6. Final check list

NO	Persuasive Factors	No	Partly	Good
1	Training is presented step by step with various ways and shapes.			
2	Presenting the new educational subjects according to main source.			
3	Explaining the necessity of presented subjects, during learning process.			
4	The learners' attitude and viewpoints be considered, in learning process.			
5	The consistency of the new educational subject with previous knowledge is explained for learner.			
6	Educational messages are presented in all phases of installation and implementation of courseware.			
7	During learning process, there is conversation whit learner as written or voice by computer.			
8	The learner can change some content of the training program on the display (such as shapes, colors, movements, etc.)			
9	The learner be able to express their emotions, sympathy and compassion in the courseware by written, recording voice and, etc.			
10	The learners have these abilities that to personalize the display and change them based on personal interests.			

- 11 The new educational contents are presented in the appropriate conditions and based on learners' needs in the daily life.
- 12 Learners learn mathematics into some simulated condition by computer like virtual shopping.
- 13 Learners receive rewards for their correct answers during learning process.
- 14 There are the opportunities that learners are enabled to put on their personal arguments and innovations in courseware.
- 15 There is an opportunity for learners that are able for making social roles based on social norms in mathematics courseware (like selecting a teacher with especial manner or face, and etc.).
- 16 The opportunities are provided for students' self-assessment during the learning process.

SUM Scours

The results are collected from all evaluators. To facilitate the integration data, for three quality checklist options is determined three numbers. So, for option "no" set number 0, "partly" set number 1, and "good" number 2. As a result, each of courseware that is able to earn more scours, it is more able to persuade primary school students in learning mathematics process. So, table 7 shows earned courseware scours after evaluating by experts. The three courseware were adopted by two experts based on checklist developed in the study. The results of analysis were impressive (see Table 7). Accordingly, the first ranked was Kousha and Nousha, failed to even gain half of the points in the proposed persuasion model at best.

Table 7. Results of courseware analysis by designed check list

Courseware Names	Experts	Scours			Total scours	Avg.
		No	Partly	Good		
DABESTANIHA	A= Courseware designer	10	1	5	11 of 32	10.66 of 32
	B= Psychologist	10	2	4	10 of 32	
	C= Researcher	10	1	5	11 of 32	
MISHA & KOOSHA	A= Courseware designer	7	3	6	15 of 32	14.66 of 32
	B= Psychologist	7	3	6	15 of 32	
	C= Researcher	8	2	6	14 of 32	
LOHE DANESH	A= Courseware designer	10	3	3	9 of 32	9 of 32
	B= Psychologist	10	3	3	9 of 32	
	C= Researcher	10	3	3	9 of 32	

4. Discussion

As pointed out in the literature review, learning and training mathematics have been always a challenge in education (Hoyles & Lagrange, 2009; Zeidner & Matthews, 2010). Add to this challenge the negative attitudes toward the course and poor educational achievements in mathematics that are of great importance. As it discussed, studies have highlighted specific issues with the student's attitude and shortcoming of math education methods. This introduction portrays necessity of the study as the main aim is to evaluate persuading features in mathematics courseware by a check list. Qualitative and quantitative research methods were employed to reach this aim. First step was to elaborate on the previous models, theories, and approaches in the persuasion. Based on the preliminary studies, 13 models, theories, and approaches were identified. These are the methods that try to persuade individuals or to change their attitudes, each of which adopted in different fields of sociology. Indeed, none of the models, theories, and approaches has been specifically designed to be used in educational

environment. However, the fact that human is the main factor in all of them, makes them suitable for our study. In the rest of the study, the previous models are analyzed using Content Analysis methods – a qualitative research method. The second step of the study requires extracting the principal rules of the 13 models. This was done by the way of an accurate study and analysis of the content of each model. The results of the surveys at these stages were 38 principles that constitute the previous models. It must be mentioned that some of the principals are common among the models. By omitting repetition of principals, we continued the research with 16 rules. The check list was designed based on these 16 criteria. At the final step, three more popular mathematics training software were prepared and analyzed based on a persuasive principles check list. The results of the analysis have shown the extent to which the rules introduced in the proposed check list have been used by the developers of the mathematics courseware. But, the results have shown the most popular mathematics courseware which its name is “Kosha & Misha”, could only earned approximately half the points of check list. It means, more than half of persuading factors are not included in the most popular courseware. Two others mathematics courseware only be able to obtain a third of points. Totally, with a brief look at these results, it can be concluded that, with regard to the persuasion issue, perhaps we will be able to overcome negative attitudes toward mathematics in school students. We hope to see better persuasive point in the mathematics courseware by using the applied results of this study in schools.

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