VOL. 11, NO. 22, NOVEMBER 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

DIGITAL *WAYANG KULIT* MODEL FOR LEARNING MATHEMATICS

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ABSTRACT

We propose a model that illustrates how digital *Wayang Kulit* (DWK) helps students learn mathematics in primary school. *Wayang Kulit* (WK) is unlikely to last long due to lack of safeguarding. Hence, there is an urgent need to preserve this cultural heritage from extinction. Drawing from the facts that there is deficient in performance of primary school children in mathematics. Henceforward, we proposed a conceptual model that illustrates how digital WK helps students learn mathematics. We use the model to develop a DWK using RAD method. The DWK, given a persona name *e-WayCool*, demonstrates how WK can be transformed into mathematics' learning object. In order to support the engagement and entertainment in DWK, the needs for effective interaction design with three dimensions of Interaction Design (IxD) theory are added. The 15-questions USE was distributed to measure the performance of DWK. The students perceived e-*WayCool* as useful (79%) and satisfying (83.4%). The result showed that the students perceived high satisfaction towards the proposed digital WK. It indicates DWK is effective for mathematics learning at primary level, and as such, the model proposed can be generalised to a wider domain.

Keywords: digital *wayang Kulit,* interaction design, conceptual model.

INTRODUCTION

Primary School Standard Curriculum (KSSR) aims to develop students' understanding of the concept of numbers and basic computing skills (Curriculum Development Division - Ministry of Education Malaysia, 2011). According to Zurina, multimedia technology has reform the current learning and teaching (L&T) activities and is successfully implemented for its advantages and capabilities (Zurina, 2005). As such, traditional L&T could be enhanced by using multimedia to improve students' understanding and appreciation of mathematics education in schools. Nor *et al.* (2009) claimed that mathematics is an important subject for science and technological careers but ironically, many students still have difficulties in mathematics learning, resulting higher failure rate. This claim is supported by Zaini *et al*. (2010) study on students' motivation towards learning mathematics. The study showed that, using the current L&T approaches, students score on motivation was low. Another study worth mentioning is by Ke and Grabowski (2007) on the effects of mathematics performance and attitudes using game-based learning among fifth-graders. The results proved that the game-based learning was more effective than drills in promoting mathematics performance. Positive students' attitudes towards the use of game-based learning in mathematics were also reported. An interview with mathematics teachers of Sekolah Kebangsaan Haji Abdul Rahman, Tokai, Kedah (SKHAR) revealed that fourty percent of the Year One student obtain poor results (40% and below) in addition and subtraction topics. School children who fail to master basic arithmetic and algebra will continue to have problems later on in related college subjects that require the use of this basic literacy in their problem-solving activities. Most observed failures and substandard performance in mathematics are due to insufficient L&T environment. Therefore, educational design of effective learning and teaching environment should be considered a key factor in the prevention and remediation of mathematical learning difficulties among students.

Taking up the problem, this paper proposes a conceptual model for teaching mathematics in primary school using animated Wayang Kulit (WK) as a feature of 'game' in the concept. The model combines the actors of WK with the contents of mathematics subject (Year One). The aim is to help create effective L&T environment that will enhance mathematics learning and at the same time preserve WK, a cultural heritage of Malaysia. Why WK? According to Wahju (2008), the function of 'Wayang' can be compared to a picture book. It enables the children to adopt many distinct characters and to act out moods, conflicts and imaginative fiction in a safe environment. Moreover, there is a close relation between imagination and thinking ability.

THE THEORIES AND DWK CONCEPTUAL MODEL

We developed our own version of DWK, also known as *e-WayCOOL*. This is a new paradigm of learning mathematics using deep learning (DeL) approach based on various pedagogical methods (e.g. presentation, exhibits, demonstration, drill and practice, tutorials, games, storytelling) and learning theories that are suitable for primary school's students (Level 1), ages 7 to 9 years old. According to Crain (2005), children at the age of seven to eleven (7 to 11) can develop the capacity to think analytically. Therefore, the design and development of DWK was based on a well-researched conceptual framework as illustrated in Figure-2.

The content design and activities in DWK are based on educational courseware development, Malay literature review on WK and ideas by expert groups from industries and education. DWK is designed and developed as an edutainment that consists of seven main components

which are the DeL approach, holistic child development, instructional design and medium, IxD theory, and learning modules that are incorporated with the established learning theories. In order to ensure that this courseware can eventually assist students to understand the contents, which is mathematics level 1, we integrated the environment of WK as a tool to make the deep learning process more engaging, effective, and expeditious and at the same time acts as a tool to preserve WK for future generations. The overall operational view of the DWK model is explained below based on Figure-2.

In general, the conceptual model DWK consists of three components which focus on how the IxD and WK is incorporated in a courseware. Figure-1 explains how WK is represented as a storytelling, Mathematics as an operations and numbers in a courseware, and IxD as a form, content, and behavior.

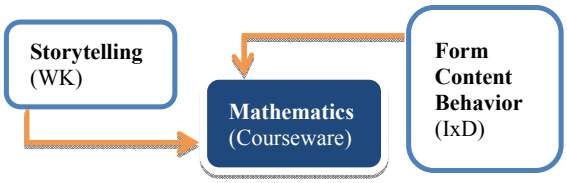

Figure-1. A proposed concept incorporated IxD and WK in a courseware.

Digital Wayang Kulit (DWK) is modeled based on the traditional WK, whereas mathematic contents is modeled based on the syllabus of level one primary school. DWK focused on L&T environment in which students should feel enthusiastics, energized, happy, and pleased (Te'eni, Carey, & Zhang, 2007). Such environment is hoped to cause changes in the users core affect as proven by the cognitive theory of multimedia learning (CToM) (Mayer, 2012). This theory emphasizes on two separete channels (auditory and visual) for processing information such as mathematics' contents in multimedia representation.

Preliminary studies and model validation were carried out via brainstorming, observations and interview. At this stage, we identify mathematics topics to be included and feedback to improve the model. Interviews with the mathematics teachers at SKHAR revealed problems faced by teachers, i.e. students are lacking basic mathematics skills originated from symbols and relationships among addition and subtraction functions. Based on the teachers' input and observations on the students' activities during mathematics lessons, the conceptual model is further improved, see Figure-2.

The details about the activities engross in this phase is described in Figure-3. This model will focus on two mathematics operations for subtraction and adding operation, using four WK actors; Sita Dewi, Ramayana, Laksamana, and Hanuman Kera Putih. Each actor signifies ones, tens, hundreds, and thousands respectively. With each actor has its own numerical representation, the math operations are realized through visualization, animation, audio cues, cinematography, and realism.

An example for addition operation is shown in Figure-2. Two Sita Dewi added to three Ramayana equals 3,200. But, if this number subtracts nine Laksamana, the result is 3,200. Then minus 9, final result is 3,191 (See Figure-2). This approach is advantageous for students in requisites of trains on the use of variables-which will only be covered in form 1 syllabus of Malaysian school system.

Deep-learning approach

To engage students' mind and spirit, the WK scenes are introduced through the stories that are delivered as a DeL approach, which is known as the thematic literature-based approach. Here, the literature is in the context means of Tok Dalang (ToD) as the main narrator to communicate with students (users) on traditional Malay oral narratives.

Furthermore, through the stories in the scenes (cinematography), students are exposed to recall their past experiences and develop their understanding, attention, and followed by retention. The process of understanding becomes more operative when the contents (i.e., mathematics in cinematography scenes) are coherent with the local culture and way of Malay life, which help the students to identify and relate themselves and their environment to the courseware.

Accordingly, the process of learning mathematics becomes more fun, enjoyable, and appealing. Hence, the students' attention and retention toward learning mathematics is achieved. This is aligned with the higher order thinking skill (HOTs) in Bloom's Taxonomy. In DWK learning module, HOTs is adopted with analyse, evaluate, and create. At the end of the lessons, students are able to create their own problems with solutions.

Malay language is used as a whole language approach in DWK purposefully to develop students' acceptance during the learning process, and with the intention that students can learn reading more effectively. The storytelling (narration by ToD) in the scenes is acquiescent to this approach. As mentioned by Bergeron (1990), the whole language concept includes the use of real literature and writing in the context of meaningful, functional and cooperative experience in order to develop students' motivation and interest during the process of learning.

Prototyping digital WK: a viable solution

A prototype of the DWK called *e-WayCool* (electronic Wayang Kulit) is developed to materialize the concept modeled above, using rapid application design (RAD) and throwaway prototype. The DWK embeds sounds and background music as these can directly affect the manner in which mathematic contents is synthesized in working memory, as mentioned by Sweller (2012) in the cognitive load theory (CLT) of multimedia learning (see Figure-3). The DWK also utilizes interaction design theory (IxD) in designing the layout and behavior of the interactions within *e-WayCool*. IxD has an interest in three dimensions, namely form, contents, and its main focus is on behavior.

Five attributes in IxD theory dimensions are adopted in DWK learning modules. These attributes are words, visual representation, physical objects, time, and behaviours. Figure- 4 and 5 are snapshots of Subtraction and Story Telling module interfaces respectively that depict the five IxD attributes. In all such cases, many hands-on exercises can be assigned to students. With the help of the five IxD attributes in DWK, they can explore a lot more in the learning modules, and get more in-depth understanding of mathematical operation (add, subtract, multiply, divide).

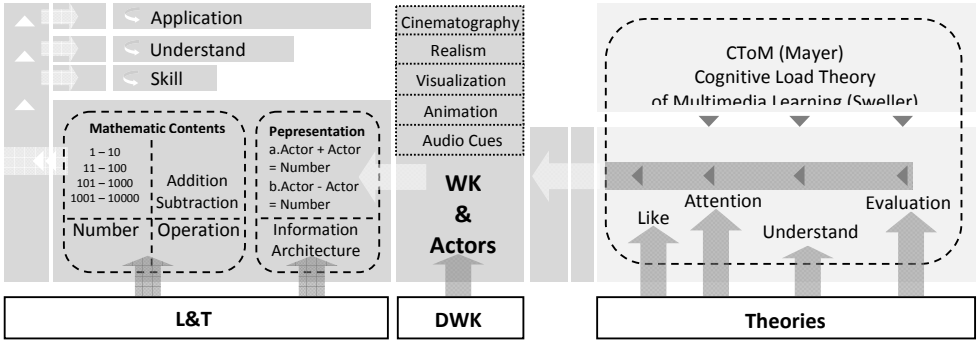

Figure-2. The model: relationship between L&T, DWK, and cognitive theories.

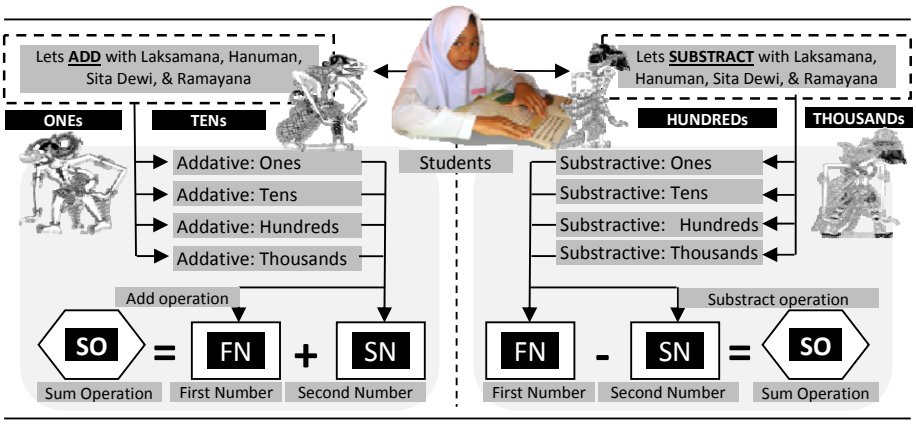

Figure-3. A proposed concept of a mathematical operation.

Figure-4. Subtraction module interface.

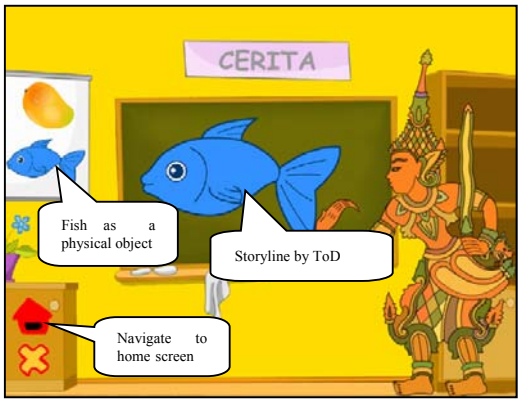

Figure-5. Storytelling module interface.

Evaluating *e-WayCOOL*

e-WayCool is evaluated via classroom survey. The participants of this survey are 30 respondents of Year 1 students of SKHAR. Usability inquiry method based on

questionnaires is used, and the questions were rephrased and asked verbally (because the children do not understand the concept of questionnaires). We adapted the 15-question USE (usefulness, satisfaction, ease of use) questionnaire (Lund, 1998) to measure the performance of *e-WayCool*. The children select their answers based on the infographics Likert Scale (smiley emoticon) (see Table-1) ranging from 1 to 5 (Read, 2007; Read, MacFarlane, & Casey, 2001; Sim, MacFarlane, & Read, 2006). Feedbacks from interviews and questionnaires are analyzed to gauge the prototype. 30 responses from the survey were recorded and analyzed using the SPSS Version 12.

Table-1. Likert scale (smiley emoticon) with toon faces classification.

	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
Scale	1	2	3	4	5
					
Category	Disagree		Neutral	Agree	

Measures of central tendency for usability and satisfaction

Table-2 indicates a positive acceptance in terms of usability as the means for all the seven items representing this aspect are above 3.70. The highest mean is for item 5 which indicates that using *e-WayCool* in learning mathematics has helped students understand the subject matter a lot better, hence makes them complete their tasks easier. Table-3 is the result for satisfaction's dimension. It also indicates a positive response since the means for all eight items are above 4.00. We can claim that e-*WayCool* is a success in terms of like, fun, pleasant and wonderful attributes.

Table-2. Data analysis of usability.

Item No	**M**
Item 1: Learning Mathematics using *e-WayCool* enables me to complete my exercise and homework faster.	3.97
Item 2: Learning Mathematics using *e-WayCool* enables me to improve my performance in Mathematics.	3.77
Item 3: Learning Mathematics using *e-WayCool* enhances my understanding of Mathematics.	4.00
Item 4: Learning Mathematics using *e-WayCool* enhances my effectiveness in learning.	3.93
Item 5: Learning Mathematics using *e-WayCool* enables me to complete my exercise and homework easier.	4.20
Item 6: Learning Mathematics using *e-WayCool* meets my learning needs.	4.07
Item 7: Learning Mathematics using *e-WayCool* increases my awareness of the importance of Mathematics in life.	3.73

The overall means for satisfaction derived from the data collected is 4.17. Such result implies that the students perceived *e-WayCool* as useful and fulfil their satisfaction in learning mathematics especially on the topics of addition and subtraction. Besides being useful and satisfying, the elements of WK in DWK have also been well accepted by the students and this is a positive indication that DWK has a great potential to be used as one way of preserving WK, one of the Malaysia's cultural heritage.

Table-3. Data analysis for satisfaction.

Item No		**M**
Item 8	Learning Mathematics using *e-WayCool* makes me feel satisfied.	4.10
Item 9	I will recommend learning Mathematics using *e-WayCool* to my friends.	4.17
Item 10	This actors works the way I want them to work.	4.07
Item 11	Learning Mathematics using *e-WayCool* is wonderful	4.10
Item 12	Learning Mathematics using *e-WayCool* is pleasant.	4.20
Item 13	I feel I need to learn Mathematics using *e-WayCool*	4.10

Item 14	Learning Mathematics using *e-WayCool* is fun.	4.30
Item 15	I like to learn Mathematics using *e-WayCool*	4.30

CONCLUSIONS

The study proves that DWK has positive attributes in assisting young children learning mathematics. DWK model supports deep learning approach where the process of learning mathematics becomes more fun, enjoyable, and appealing. Hence, the students' attention and retention toward learning mathematics is achieved. In *e-WayCool* learning module, deep learning is adopted with analyse, evaluate, and create. At the end of the lessons, students are able to create their own problems with solutions.

We developed *e-WayCool* as a small-scale courseware purposely to evaluate our DWK model for investigating the appealing and satisfaction level of the students towards learning mathematics. The finding from the survey ascertained that the students perceived DWK as useful (79%) and satisfying (83.4%). The results implied that students have shown high interest level in studying mathematics in WK dimension. This is an evident that the DWK model translated from the traditional WK is valid as well as usable, although its generalizability in different contexts, other than mathematics and the selected topics, is yet to be tested. With this success we believe that we are on the right track of preserving the national heritage in a creative way, i.e. at the same time benefit children in learning basic skills of mathematics.

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