Development and Validation of the Game-Based Learning Module to Enhance Mathematics Achievement, Positive Learning Behaviours and Pro Social Behaviours

Pembangunan dan Kesahan Modul Pembelajaran Berasaskan Permainan bagi Mengukuhkan Pencapaian Matematik, Tingkah Laku Pembelajaran Positif dan Tingkah Laku Sosial

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Abstract

The main aim of the study was to develop the Game Based Learning Module (GBLM) to enhance mathematics achievement, and to inculcate positive learning behaviours and pro social behaviours among pre-schoolers. The mathematics achievement include number concepts and number operations. The positive learning behaviours include three main aspects, which are competence motivation, attention/persistence and attitude toward learning. The pro social behaviours consist of 13 indicators with clear operational definition. In order to achieve the goals, games play approach and constructivism's 5E model were applied throughout the module. 12 different games were designed and developed by the researcher. All these games were developed based on the availability of the materials in the context of rural preschools. The module was designed based on the nine main elements in the Morrison, Ross, Kalman and Kemp (MRKK) instructional design model. The module has been validated by five experts. The content validity coefficient was found to be very high with 0.92 for part I and 0.94 for part II. Part I refers to the appropriateness of every game to learning standards. Part II refers to the appropriateness of generic skills which are integrated through the games. Based on the high content validity coefficient attained, hence, the GBLM module can be implemented in the real context.

Keywords   Game-Based Learning Module (GBLM), preschool, positive learning behaviours, pro social behaviours

Abstrak

Tujuan utama kajian ini adalah untuk membangunkan modul pembelajaran berasaskan permainan (MPBP) bagi meningkatkan pencapaian matematik, dan memupuk tingkah laku pembelajaran positif dan tingkah laku prososial dalam kalangan kanak-kanak prasekolah. Pencapaian matematik termasuk konsep nombor dan operasi nombor. Tingkah laku pembelajaran positif termasuk tiga aspek utama, iaitu dorongan kecekapan, tumpuan/ pengekalan dan sikap terhadap pembelajaran. Tingkah laku prososial terdiri daripada 13 indikator dengan definisi operasi yang jelas. Bagi mencapai matlamat, pendekatan bermain permainan dan model konstruktivisime 5E diaplikasikan merentasi modul. 12 permainan yang berlainan direka cipta dan dibangunkan oleh pengkaji. Kesemua permainan ini dibangunkan berasaskan kebolehdapatan bahan-bahan dalam konteks prasekolah luar

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bandar. Modul direka bentuk berasaskan sembilan elemen utama dalam model reka bentuk berarahan Morrison, Ross, Kalman dan Kemp (MRKK). Modul telah disahkan oleh lima orang pakar. Pekali kesahan kandungan didapati sangat tinggi dengan 0.92 untuk bahagian I dan 0.94 untuk bahagian II. Bahagian I merujuk kepada kesesuaian setiap permainan dengan standard pembelajaran. Bahagian II merujuk kepada kesesuaian pengintegrasian kemahiran generik merentasi permainan. Berdasarkan kepada pekali kesahan kandungan yang tinggi, maka, MPBP boleh dilaksanakan dalam konteks sebenar.

Kata kunci Modul Pembelajaran Berasaskan Permainan (MPBP), prasekolah, tingkah laku pembelajaran positif, tingkah laku prososial

INTRODUCTION

Early mathematics education, particularly the number concepts and number operations, plays a very important role in human life and is important for children to master at an early stage of schooling to ensure mastery of mathematics topics and other important topics at the higher stage of science and mathematics (Gersten, & Chard, 1999; Jordan, Glutting, & Ramineni, 2009; Jordan, Kaplan, Ramineni, & Locuniak, 2009). However, the practice of teaching and learning numbers and number operations in the classroom today is still tied to the traditional teacher-centred approach of direct teaching (Rohaty, 2003) and does not show the role and involvement of the students (Mullis, Martin, Gonzalez, & Chrostowski, 2004; Mullis et al., 2008). Enthusiasm of teachers in using work books or activity books without encouraging children to actively interact with the environment has violated the principle of children's learning (Rohaty, 2003) and this situation does not promote effective and meaningful learning as the emphasis is more on memorization without understanding. Learning without proper and profound understanding causes a lot of problems or results in weaknesses in the mastery of number concepts and number operations especially among pre-school pupils. Teaching should emphasise the development of students' potential through active participation in the planned activities in addition to the emphasis on inquiry discovery, exploration, learning through play and contextual learning. Learning through play is extremely important and needs to be combined with everything that children do (Nor Hashimah & Yahya, 2003) in a fun way (Kementerian Pelajaran Malaysia, 2009). Learning also needs to be able to foster positive learning behaviours, particularly positive attitude toward self and the topics studied (Reys, Reys, Lapan, Holliday, & Wasman, 2003) and the willingness of students to learn (Tarr et al., 2008). Additionally, the country's education system is being transformed with the hope of producing citizens who appreciate the value of integrity, fairness, cooperation and altruism especially in this multi-racial country. Therefore, fostering pro social behaviour from an early stage of schooling through daily activities is important (Catapano, 2005) and should be a critical component of school readiness (Blair, 2002). Thus, the researcher took the initiative to develop a teaching module called the Games Based Learning Module (GBLM).

The GBLM was developed by combining the constructivist and objectivist learning theory as proposed by (Johannes, 2006) which correspond to the instructional design model of Morrison, Ross, Kalman and Kemp (MRKK) which is more flexible and allow for modifications in accordance with the requirements (Akbulut, 2007). Learning outcomes in the GBLM module is based on the learning standards outlined in the National Standard Curriculum for Preschool (NPCS), which includes the number concepts and number

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operations arranged in a hierarchy based on the revised Bloom's Taxonomy (Krathwohl, 2002). Processing theory and cognitive load theory are applied in the modules to take into consideration information delivery and to reduce the cognitive load. Bandura's Social Learning Theory which emphasizes learning through observation and modelling is also applied specifically to foster pro social behaviour. Piaget's Cognitive Constructivism Theory and Vygotsky's Social Interaction Constructivism Theory which emphasize the contribution of student's pre-knowledge and active involvement to learning are also included. The 5E learning model (Engage, Explore, explain, elaborate, Evaluation) was used as the framework for the writing of the lesson plans. Information and communication technology is applied in the engagement phase at a minimum level. Exploration activities are provided in the second phase and gaming activities are made available in the elaboration phase. The ultimate goal of the GBLM is to improve the mathematics achievement, as well as to enhance positive learning behaviours and pro social behaviours.

Development of the GBLM

The GBLM was developed based on the MRKK instructional design model with nine elements, namely instructional problems, learner characteristics, task analysis, instructional objectives, content sequencing, instructional strategies, designing the message, development of instructional and evaluation instruments. The nine elements are interdependent and learner-centered (Gustafson & Branch, 2002; Akbulut, 2007; Morrison, Ross, Kalman, & Kemp, 2011). The following sections describe how the researcher developed the GBLM Module based on the elements in the MRKK model.

Instructional Problems

The first step of the designing process is to identify the needs of the target group and identify the specific problem that needs to be solved (Noah, & Ahmad, 2005; Morrison et al., 2011). Thus, a needs assessment was carried out to determine whether the preschool teachers need extra supporting materials such as a module as a guide to implement learning through play. Table 1 shows the analysis of the needs assessment which was carried out.

For items four and five, all the teachers involved in this needs analysis study agreed that learning number concepts and number operations through games based activities is necessary in preschools and they need a teaching module as a guide to implement learning through play. For items six and seven, all the teachers agreed that the use of games based module can foster pro social behaviour and positive learning behaviours among pre-schoolers. Therefore, the GBLM was developed for the preschool number concepts and number operations through the integration of games in the module through games based approach.

Characteristics of the Learners

The researcher focused on the students' prior knowledge, age, ethnicity and the existing facilities at the school. The target group of the GBLM is pre-schoolers who are 5 years of age on 1st January 2013. The researcher assumed that the students have attended early

Table 1 Results of the needs assessment analysis

	Item	Yes	No	Agree	Disagree
1	Implement specific modules for teaching the preschool number concepts and number operations.	4	3		
2	Implementation of the module is effective in improving the mastery of number concepts and number operations.	4	3		
3	Learning the number concepts and number operations by pre-schoolers requires a module based on the National Preschool Standard Curriculum (NPSC).			7	0
4	Learning the number concepts and number operations through games is necessary in the preschool.			7	0
5	Teaching module for the number concepts and number operations based on games is necessary as a guide for teachers.			7	0
6	Games based module can foster pro social behaviour among pre-schoolers.			7	0
7	Games based module can foster positive learning behaviours.			7	0

childhood education at nurseries. The initial survey conducted at three rural primary schools in Miri revealed that the preschool rooms do not have access to computers and LCD projectors.

Task Analysis

Task analysis aims to define the content to be included in the instruction. It begins with the instructional problem or needs assessment and learners' analysis which should be carried out first. Task analysis can be divided into two main categories, namely topic analysis and procedure analysis (Morrison et al., 2011). The researcher referred to the NPSC early mathematics education to study the students' prior knowledge of number concepts and number operations. From the analysis, the researcher discovered that the students have already been exposed to pre-numbers before the number concepts and number operations. Procedure analysis determines the steps needed to complete a task (Morrison et al., 2011). The GBLM Module incorporates constructivism strategies in teaching and learning topic of number concepts and number operations. The strategies included in the module are the 5E learning cycle (Engage, Explore, Explain, Extend and Evaluate), integration of games based learning, inquiry-based teaching and learning, and contextual learning.

Instructional Objectives

Instructional objectives help the designer to select appropriate activities and resources to facilitate effective learning. It also provides a framework for devising ways to evaluate

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students' learning (Dick, 1996; Morrison et al., 2011). Learning objectives in the GBLM Module is based on the learning standards listed in the NPSC (Kementerian Pelajaran Malaysia, 2009).

Content Sequencing

The learning-related scheme suggests ways of sequencing the content based on learner characteristics identified in the learner analysis. This scheme considers the difficulty of materials, learners' prerequisite knowledge and learners' cognitive development. Concept-related scheme suggests sequencing based on the relationships between the concepts (Morrison et al., 2011). The GBLM uses both learning-related and concept-related sequencing scheme. These two sequencing schemes are matched with the content sequencing in the NPSC.

Instructional Strategies

A well-designed instructional strategy prompts the learner to actively make connection between the learner's existing knowledge and the new knowledge presented in the instruction (Morrison et al., 2011). Therefore, the researcher has made the decision to incorporate strategies such as the 5E approach (Engage, Explore, Explain, Extend and Evaluate) learning cycle, inquiry-based teaching and learning, games based learning and contextual learning across the module.

Designing the Message

Message design process can be divided into three main parts which are pre-instructional strategies, message design for text, and the use of pictures and graphics in the instructional materials (Morrison et al., 2011). As the pre-instructional strategies, behavioural objectives are stated at the beginning of each activity to inform the learner of what is expected to be achieved at the end of a lesson. The researcher used the global signal for the activities' title (Font: Time News Roman, size 12, Capital Letter), and page number (Font: Time News Roman, size 12, Bottom-centred). The graphic and pictures used in the module function as decoration, representation, organization and transformation.

Development of Instruction

In terms of the development of the instruction, it is important to stay focused on solving the instructional problem that has been identified in the needs assessment. Learners' familiarity with the content and terminology is determined based on the learner analysis and topic analysis (Morrison et al., 2011). Therefore, in connection to the module which is to be used by young learners, shorter words and active sentences are used to make the text concrete. In addition, appropriate diagrams and graphics are also used to increase the concreteness of the text.

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Evaluation Instruments

Formative assessment is carried out during the process of teaching and learning in the GBLM to get feedback from the students. Additionally formative assessment is also accomplished through the exercises and worksheet that are provided at the end of every teaching and learning process. Assessment of student work is also made in the form of observation. Teacher assessment is made through written reflection at the end of the teaching and learning as provided in the guidelines.

Validation of the GBLM

Content validity typically involves specific examination of individual items to ensure that each objective of the module is appropriately addressed (Morrison et al., 2011). Hence, the researcher presented the module to five experts to test for content validation. According to Sidek and Jamaludin (2005), questionnaire for content validity of a module can be constructed by the researcher based on the scope and objectives of the module. In this study, there were two parts for content validity. Part I assesses the suitability of each game with the learning standards listed. Part II consists of 15 items with a five-point Likert scale which leads to the accuracy of the integration of generic skills through play. At the same time, the qualitative comments provided by the experts were also considered for module improvement. The following table shows the mean values for each item. Content validity value was calculated using the formula shown below (Noah & Ahmad, 2005):

$$\text{Content validity coefficient} = \text{x } 100\%$$

Table 2   Content validity coefficient for each game

No.	Games	Content validity coefficient
1.	Rambutan Oh Rambutan	0.92
2.	Kita Sama	1.00
3.	Kita Sama Besar	0.60
4.	Dominoku	1.00
5.	Siapa Cepat	0.80
6.	Mengelilingi Dunia	0.80
7.	Siapa Besar Mari Makan	1.00
8.	Siapa Kecil Dimakan	1.00
9.	Mari Menambah	0.80
10.	Burger	1.00
11.	Mari Memancing	1.00
12.	Mari Menjaring	1.00
Mean		0.92

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Table 3 Content Validity Coefficient for Generic Skills through Games

No.	Generic Skills	Content validity coefficient
1.	Games encourage fun learning.	0.96
2.	Games encourage learning through play.	0.96
3.	Games encourage social interaction among children.	0.92
4.	Games encourage intellectual thought during the game play among children.	0.92
5.	Games attract children's interest.	1.00
6.	Games attract children's attention.	1.00
7.	Games encourage the retention of children's learning.	0.96
8.	Games promote student-centred learning.	0.96
9.	Games allow scaffolding among children.	0.96
10.	Games encourage teacher scaffolding to children.	0.92
11.	Games provide an opportunity for children to make their own decisions.	0.96
12.	Games encourage collaboration among children.	0.96
13.	Games encourage compliance by children.	0.96
14.	Games encourage positive competition.	0.84
15.	Games promote tolerance among children.	0.84
Mean		0.94

Content validity coefficient that is equal or higher than 70% is considered as high validity (Noah & Ahmad, 2005). All the items in Table 2 showed high content validity coefficient except for item 3. All the items in Table 3 also showed high content validity coefficient. Analysis by using Statistical Packages for Social Science (SPSS) 18.0 also showed that the Cronbach's Alpha reliability coefficient for the module is 0.94. According to Noah and Ahmad (2005), Cronbach's Alpha coefficient of 0.85 is considered very high. Based on the high reliability and validity coefficient attained, it is concluded that the GBLM is acceptable and thus can be implemented in the real context.

In order to improve the quality of the GBLM, 33% of the games and activities in the GBLM were piloted in a school with the same context as the real research location. The purpose of trying out the activities is to find out the applicability of the module and the time needed for each lesson. Furthermore, by carrying out the pilot test, other problems could be identified, such as availability of the school's facilities. The GBLM will be tested under real mathematics classroom setting. The effectiveness of the GBLM in enhancing mathematics achievement, positive learning behaviours and pro social behaviours will be tested through experimental method, in which pre-post test will be used with the treatment and control groups.

DISCUSSION

Development of teaching and learning module need to consider various important aspects including targeted groups, currents needs, alignment with curriculum, suitable teaching and learning theories as well as feasibility of the module in the real context. In this study, module was developed by researcher and content validity has been assessed by experts

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of subject matter. Experts were confident in the use of this module to help mathematics learning among pre-schoolers. The activities provided is believed to be able to attract children's attention and interest to actively engage in their own pace. This is especially important to provide opportunities for them to play together with their peers in addition learn mathematical concepts which are embedded in the games activities.

Less stressful learning environment and game scenarios that give the victory to the players may provide a good learning experience for children. Besides, the advantage from repetition of games allow children not to be worried of trying even though the possibility of losing is always there. These experience offer an important platform in helping children foster competence motivation and confidence in themselves. Social interaction between children through games activities can lead to application of various social skills such as cooperation, wait for their turn and follow rules that lead to pro social behaviours in children.

CONCLUSION

The GBLM is developed with the aim of enhancing mathematics achievement, positive learning behaviours and pro social behaviour. During the development process, the researcher has applied the nine elements from MRKK instructional design model. After completing the development of the GBLM, the validity of the module was identified by referring it to five experts. Analysis shows that the GBLM has high reliability and validity. Thus, the module is acceptable and can be implemented in the real context.

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