Smart mathematics: a kindergarten student learning media based on the drill and practice model

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Abstract. Teachers still face difficulties in catching up to new teaching methods, especially the kindergarten teachers. The problem is their inadequate application of relevant advanced learning media technology. This should have been done by integrating learning and playing, in an enjoyable atmosphere, to stimulate the creativity of children. This research aimed to enhance kindergarten cognitive ability of children in understanding general knowledge, general science, and the concepts of shape, pattern, size, and color using the drill and practice model, and identify effectiveness application of interactive multimedia on the learning outcome of students. This development of interactive multimedia application was storyboard-driven and employed the Hannafin and Peck methodology. During the research, 30 Islamic kindergarten student all over Batam was involved. The interactive multimedia application evaluation included pre-test and post-test. The data from these tests were then analyzed using the quantitative descriptive method. The evaluation consisted of the functional and significance test. Based on the pre-test and post-test results, the significance test resulted in Sig. (2-tailed) < 0.05, which indicated the effectiveness of the interactive multimedia application.

1. Introduction

Preschool education is an educational stage prior to primary school. This stage prepares children for their subsequent educational stage. Cognitive abilities should be stimulated and developed early [1]—as early as 4-5 year old. These abilities consist of general knowledge, general science, concepts of shape, pattern, size, and color [2]. The conventional teaching method employed currently, however, results in the children’s low cognitive ability. The lack of the opportunity for student to learn actively causes inadequacy in the learning outcome. To develop the children’s cognitive ability, they should have been allowed to play [3]—to learn in an enjoyable manner. This is what should have been done in the current playgroup and kindergarten teaching to improve the outcome. Teachers can integrate learning and playing to enhance their students’ creativity. Many schools still rely only on conventional learning media such as books and pencils. Textbook and workbook still become the main source of material during the learning process. However, every child has her/his own learning styles—visually, auditory, or kinesthetic [6]. If teachers only use these traditional media, the students’ interest to study will die out—hence, the need for preschool teachers to be creative in their use of learning media according to the children’s development stage.
Meanwhile, media such as games have become common to the public from children to adults, and are still likely to expand. Younger children nowadays are highly interested in gadgets and adept at using them. However, children still find educational games uncommon as most of them play games without the supervision or accompaniment of their parent or guardian. The implementation of educational games in the preschool teaching process could enhance its effectiveness. These two concepts—learning and playing integration and enjoyable learning—are engaged in educational games; students do their learning while playing game. For parents and teachers this can be considered as an alternative for a more appropriate game—to fulfill their children’s needs in their growth. ICT (information and communication technology) media proficiency has been the requirement for all teachers at every level, from preschool and beyond, and consequently, most of them have been utilizing the media. This research attempted to develop the learning media capable of facilitating kindergarten children learning process in the development of their cognitive ability regarding general knowledge, general science, and concepts of shape, pattern, size, and color through drill and practice model, and to identify interactive multimedia application’s effectiveness on the students’ learning outcome. The drill and practice model comprised of exercises and practices. The process could be repeated until the intended skill level is achieved, therefore giving more concrete learning experience [3]. This model has usually been employed in mathematics, vocabulary, and foreign language teaching.

2. Method
During the learning media development, the Hannafin and Peck method [4]—an interactive multimedia application development design method—was employed in this research. This method consists of three important stages (the Needs Assessment, Design, and Development and Implementation stage), each followed by comprehensive evaluation and revision.

![Flowchart](image)

**Figure 1.** The Hannafin-Peck Development Stages

Figure 1 illustrates the Hannafin-Peck development stages in the multimedia teaching application. This research focussed on designing learning media to sharpen kindergarten children’s cognitive ability regarding general knowledge, general science, and concepts of shape, pattern, size, and color based on the drill and practice model. The drill and practice model is part of the Computer Assisted Instruction (CAI), which usually includes models of drill, simulation, tutorial, and game. During this research, Islamic kindergarten students, aged 4 to 5 year old, all over Batam were involved in the process. Quantitative tests was assigned in this quasi-experiment in the form of pre-test and post-test. Quasi-experimental research design incorporates systematic assignment of certain condition, and observation of a group’s outcome. Pre-test was incorporated in the research design to assess the initial state and post-test the end state. One classroom was used in the experiment to determine the effectiveness of the interactive multimedia learning application.
3. Results and Discussions

3.1. Need Assessment Stage
The first stage was the need assessment stage—determining the necessity of the learning media development. The surveys and feedbacks indicated the need of learning media development in mathematics and the identification of shape, pattern, and color in the surrounding objects, and its application in drawing lessons. To take one example, patterns encompass triangle, circle, square, rectangle, and other polygons. These usually only taught through illustrations or written descriptions. The descriptions and illustrations, however, could have been alternated with activities involving educational games—for example, by first mixing and matching these shapes and patterns in the introduction to facilitate comprehension.

The surveys and feedbacks was used as a base to identify the students’ needs, required environment, system, and infrastructure—the required hardware and software. The minimum hardware requirements to access the system or multimedia application are 1 GHz processor and 512 MB RAM (for most platforms, such as desktop PC, laptop, smartphone and tablet). The device must also support Adobe Flash Player. The system requirement specification of this drill and practice model are illustrated in Figure 2.

![Figure 2. System Requirement Specification](image)

Figure 2 shows a student answering some questions on the learning application on his preferred platforms. The system will display some questions and give reward for every correct answer. This drill and practice model gives an enjoyable learning experience and is highly recommended for 4-5 year old kindergarten students to prepare them for their subsequent educations.

3.2. Design Stage
The second stage of the Hannafin-Peck Model was the actual designing of the eLearning experience. This stage involved designing the storyboard or outline of the aspects, exercises, evaluations, and rewards in the online multimedia application. As has been elaborated above, from the surveys, it could be surmised that it was essential to facilitate an understanding of mathematics and concept of shapes and patterns, therefore the exercises included assembling, matching, and coloring certain object. To make the learning more enjoyable, there would be variations in between the exercises, such as describing certain object and coloring the corresponding picture. After designing the storyboard, scriptwriting also had to be done. This necessitated writing documents containing explanations needed for an exposition, such as the perception of visual [7], auditory, behavioral, and linguistic element. In this interactive multimedia application, a mixed navigation structure—used mostly in multimedia application development—was implemented as its navigation structure. This structure required branching for the display. The colors and patterns used were the object’s original colors and patterns, mostly the vivid ones such as red, green, blue, and yellow. These vivid colors were chosen for its cheerfulness, which was appropriate for children this age, to create a more enjoyable learning. Sounds were added to liven up the media. They would be played, for example, at the start of the application, during an exercise, and at the end of it. These were extracted from the Modoo Marble Indonesia game (http://www.labusel.com), in .wav format. The typography used in this application was the infant letter for kids, with the Comic Sans MS typeface. Its properties—such as the size—could be adjusted to adapt to the illustrations and account for word stresses, creating an overall dynamic look. The exercise, on the other hand, applied the Arial typeface to facilitate easier reading and comprehension.
Table 1. The Smart Mathematics Multimedia Application Storyboard

| Storyboard | Description |
|------------|-------------|
| ![Storyboard Image](image1.png) | The interactive multimedia application’s main menu and page. The exercises consist of assembling, mixing, and coloring certain objects. The shape, color, and pattern’s layout is designed by considering 4-5 year old children’s preferences. The assembling, mixing, and coloring menu is provided together with the exercise menu. An example of a menu—assembling shapes into a car, with some preset assets. Students put the appropriate shapes, patterns, and colors together based on their imagination and previous learning experience. The students also learn to identify numbers, letters, and surrounding objects. There is a page displaying their result—succeed or fail—and the explanatory answer. |

3.3. Development / Implementation Stage

The third stage was the learning media development and implementation. The hardware specification for the development was Intel® Core™ i5 4210U 2.40 GHz processor, 4GB RAM, and 500 GB hard disk drive. For the software, Adobe Flash CS 6, Adobe Illustrator CS 6, and Audacity on Windows 10 Pro 64-bit Operating System were used during the development. In this stage, the interactive multimedia application development involved designing the main page, menus—including their buttons and structuring—, exercises, feedbacks, and the explanatory answers.

![Figure 3. The Smart Mathematics Multimedia Application’s Main Page](image2.png)
On the Smart Mathematics multimedia application’s main page, there are interactive menus to learn alphabets, match patterns, assemble shapes, and color certain objects. Users can click, drag and drop objects. In addition, there are also several navigational buttons: the Home button is used to return to the main page, the Retry button to retake the exercise, the Explanation button to view the explanatory answer to a question, and the Next and Previous button to go to the next and previous page respectively.

![Smart Mathematics Multimedia Application’s Pattern Matching and Shape Assembling Pages](image)

Figure 4. The Smart Mathematics Multimedia Application’s Pattern Matching and Shape Assembling Pages

The explanatory answers are also given for all questions in each category on every level. Each category—alphabet learning, pattern matching, shape assembling, and object coloring—is made up of five questions. For every given answer, there is a succeed/fail window as a response to the answer—whether it is right or wrong.

3.4. Evaluation and Revision Stage

The evaluation was done using one classroom as the experiment classroom. The experiment classroom consisted of 30 students. In the evaluation’s first step a pre-test was given. A treatment was then given using the interactive multimedia application. Finally, a post-test was given to measure the difference before and after the treatment was given. A t-test analysis was then conducted on the pre-test and post-test result. The t-test analysis was run to measure the significance in the difference between the experiment classroom’s pre-test and post-test result. The following were the hypothesis tested:

a. If the probability or Sig. (2-tailed) < 0.05, then there was a significant difference between the pre-test and post-test result.

b. If the probability or Sig. (2-tailed) > 0.05, then there was no significant difference between the pre-test and post-test result.

The t paired samples statistics are shown in table 2, paired samples correlations in table 3, and paired samples test results in table 4.

|                   | Mean | N  | Std. Deviation | Std. Error Mean |
|-------------------|------|----|----------------|-----------------|
| **Pair 1**        |      |    |                |                 |
| Pre-test          | 76,333 | 30 | 27,5727        | 5,03398         |
| Post-test         | 96,333 | 30 | 10,98065       | 2,00478         |

Table 2. Paired Samples Statistics.

Table 2 summarizes the samples’—pre-test and post-test’s—statistics. The pre-test had 76,333 as its mean score, while the post-test 96,333. The respondents consisted of 30 students.
Table 3. Paired Samples Correlations.

| Pair | Pre-test & Post-test | N  | Correlation | Sig. |
|------|----------------------|----|-------------|------|
| 1    | Pre-test & Post-test | 30 | .393        | .032 |

Table 3 shows the correlations of 0.393 between the two samples—the pre-test and post-test—which were low [5]. The pre-test was the preliminary test conducted before the treatment was given—before using the interactive multimedia learning application. The post-test, on the other hand, was the final test conducted after the treatment. There was a significant increase in the post-test mean; the post-test mean was 20.0 points higher than the pre-test mean.

Table 4. Paired Samples Test.

| Paired Differences | Mean | Std. Deviation | Std. Error of the Difference | 95% Confidence Interval | Sig. (2-tailed) |
|--------------------|------|---------------|------------------------------|-------------------------|----------------|
| Pair 1 Pre-test - Post-test | -20.00000 | 25.35948 | 4.62999 | -29.46939 to -10.53061 | .000 |

The test resulted in the probability or Sig. (2-tailed) of 0.00—which was smaller than 0.05. It could be concluded then, that there was a significant difference between the pre-test and post-test.

4. Conclusion
The t-test concluded that there was a significant difference on the result of the tests assigned to the experiment classroom regarding the use of the interactive multimedia learning application. The pre-test’s mean was 76.3333 and the post-test’s 96.3333; there was a 20.0 points increase. Based on the t-test, with significance of 0.05 (5%) and Sig. (2-tailed) of 0.00—which was smaller than 0.05—the difference was significant. The concept of basic cognitive ability regarding general knowledge, general science, and concepts of shape, pattern, size, and color had successfully been applied into the interactive multimedia application for preschool (4-5 year old) children, using the drill and practice model. This remarkable evaluation result indicated that the application could be of help in sharpening their shrewdness, creativity, and imagination.

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