MathDroid Application Development on Three-Dimensional Geometry Materials

J Juariah*, A H Syaf, I Rohimah, H Sugilar and R Kariadinata
Mathematics Education Program, UIN Sunan Gunung Djati Bandung
Jl. A.H. Nasution No. 105, Bandung 40614, Jawa Barat, Indonesia

*juariahtk@uinsgd.ac.id

Abstract. The purpose of the present study is to figure out the process of developing MathDroid application as a mathematics instructional medium to teach three-dimensional geometry. This Research and Development employed ADDIE development model, consisting of five phases including analysis, design, development, implementation, and evaluation. The validation of MathDroid application was done by an expert in three-dimensional geometry and an expert in instructional media. The research subjects were students at SMP Negeri 1 Babakancikao, Purwakarta, Jawa Barat. The research instruments were a mathematics test, questionnaires, and media validation sheets. The results revealed that, based on expert validation and limited testing, the developed MathDroid was considered very good and feasible and improved student achievement in mathematics and that students responded positively to it.

1. Introduction
The use of Android smartphone as a mathematics instructional medium is a part of technology utilization. Android is a mobile operating system developed by Google, based on Linux, and designed primarily for smartphones [1],[2],[3],[4]. The ever-growing Android applications and the ever-increasing use of Android mean the ever-increasing number of Android users [3]. It is necessary to take strategic steps to make Android applications useful for students as learning media. The developed Android-based mathematics instructional medium is a smartphone application called “MathDroid”.

MathDroid contains animations about elements and properties of cubes and cuboids as well as exercises. This application is expected to help students in learning mathematics instructional materials and motivate them to study [5],[6]. MathDroid is a mobile software that can provide the users with information so they can acquire knowledge and skills and improve their attitudes in accordance with the objectives of learning mathematics. Through MathDroid, students can study mathematics anytime and anywhere, in and outside the classroom [7],[8].

The result of a previous study on the implementation of MathDroid as an instructional medium show that it received positive responses from eight grade students and improved their interests in learning mathematics. Android applications have been widely used for mathematics instructional media[9]. However, MathDroid is very simple and easy to use because it has undergone several phases of material and media testings. The material testing is conducted to avoid conceptual misconceptions, and the media testing is conducted to simplify its use and avoid errors when used.
This study attempted to examine the results of expert validation and limited testing of the developed MathDroid and students’ mathematics learning outcomes and responses to MathDroid. In this study, the researchers used MathDroid as a mathematics instructional medium. MathDroid is perfect for use anytime and anywhere to improve students’ mathematical understandings, easy to use, and makes learning easy [7] because it presents the learning materials by showing moving image of three-dimensional characteristics. Instructional media can be used to improve students’ mathematical understandings. It is expected that students are motivated to learn mathematics and be able to improve their understanding about mathematics concepts. Therefore, a proper instructional medium is necessary during the teaching and learning process.

2. Methods
This study employed a Research and Development (R&D) method. The development model was referred to the ADDIE model; i.e., analysis, design, development or production, implementation or delivery, and evaluation [10]. In the analysis phase, literature and field studies were carried out. The validation of the developed MathDroid material and application was done by an expert in mathematics instructional materials and an expert in instructional media. The design phase includes the making of overall media design (storyboard), material design, test and answer key construction, and background and icon selections. The development phase included the MathDroid production and validation. The implementation phase was done involving 57 eight grade students at SMP Negeri 1 Babakancikao, Purwakarta. The evaluation was carried out through a pretest and posttest to find out students’ understanding before and after using MathDroid.

The research subjects were eight grade students at SMP Negeri 1 Babakancikao, Purwakarta, Jawa Barat. The research instruments were tests, product validation sheets, and attitude scale measurement sheets. The software applications used to develop Android-based mathematics instructional media included: Windows 7, Local Web Server Application (XAMPP), Web Browser Code Editor (Adobe Dreamweaver/Eclipse/Notepad++/dll), and Adobe Photoshop JQuery Mobile.

3. Results and discussion
The development of MathDroid consisted of five phases as follows:

3.1. Analysis phase
The results of the literature review revealed that the mathematics instructional media should display good appearance, texts, and colors to impress users. The results of interviews with mathematics teachers, the associate principal for curriculum, and the principal at the school where the research was conducted revealed that no one of the teachers had ever used Android smartphones as instructional media. In addition, students’ mathematical understandings were still low, especially of the properties and elements of three-dimensional objects.

3.2. Design phase
The design phase began with creating the storyboard, designing instructional materials about properties and elements of cubes and cuboids, constructing test and the answer key, and selecting background and icons. The icon of the developed mathematics instructional media was Rubik’s Cube. It was selected because of its cubical shape and colorful appearance that made it eye-catching.

3.3. MathDroid development phase
This phase included MathDroid production and validation. Material validations were done two times to ensure that MathDroid is suitable for use as instructional media. The first validation result revealed that in general MathDroid could be considered very good and suitable for use but with some improvements to be made. The second validation considered that it was very good and suitable for use.

The first media validations were conducted two times. At the first time, the validation revealed that in general MathDroid could be considered very good and suitable for use but with some improvements
to be made. After the improvement was made and re-validation was undertaken, it was revealed that MathDroid could be considered very good and suitable for use. The second media validation was conducted one time, and it was revealed that in general MathDroid could be considered very good and suitable for use. Despite the fact that some improvements should be made to the MathDroid documentation, but no improvement needed in the MathDroid application. The result of validation conducted by a small group revealed that MathDroid could be considered very good. The improvement was made by adding a background to the main menu display. What follows is the display of the main menu and content menu.

Figure 1. Main Menu and Content Menu

Figure 1 shows that on the main menu there are four menus. The “Konten/Materi” menu has two buttons, namely Kubus (cube) and Balok (cuboid). When one of them is pressed, there will appear three options: unsur (element), sifat (property), and info. On Kubus or Balok menu, there are elements of three-dimensional objects and several buttons of how to determine diagonal planes and space diagonal.

The result of revision by the expert in instructional materials is: answers to questions in the exercise besides “Benar” (true) or “Salah” (false) and steps to answer the questions as shown in Figure 2. The result of revision by the expert in instructional media is: The revision was made by creating attachments about the development and documentation method, adding a back to the previous menu navigation button, randomly generating questions every time the exercise is accessed, adding questions, removing sounds, improving animated images, and discussions under the animation.
Figure 2. Result of Revision by Expert in Instructional Materials

Figure 2 shows the result of revision made to the exercise menu. The revision was made by adding a detailed explanation about how to answer the question.

The animation before and after revision is shown in Figure 3.
Figure 3 shows the difference between the animation before and after revision. The revision included the change in the color of every side. The next step was testing. The testing was very important to find out if the functions in the application can run correctly and to find out deficiencies or errors to be fixed. The testing was done by transferring Android Package (.apk) file for offline installation through a Bluetooth or USB cable connection to LG L80 smartphone equipped with 1.2 GHz Dual Core Cortex-A7 Processor, Android 4.4.4 (KitKat), 1GB RAM.

A feasibility test was conducted by experts in instructional materials and media after the revision. The validation continued to be done until it stated that MathDroid was feasible to use. The three expert lectures considered MathDroid very good. The result of validation is presented in Table 1.

| No. | Expert               | Number of Questions | Score  | Ideal  |
|-----|----------------------|---------------------|--------|--------|
| 1   | Expert in Material   | 15                  | 75     | 65     |
| 2   | Expert in Media 1    | 15                  | 75     | 61     |
| 3   | Expert in Media 2    | 15                  | 75     | 68     |
| Total|                      | 45                  | 225    | 189    |

\[
P = \frac{\sum \text{skor}}{\text{skor ideal}} \times 100\% = 86.22\%
\]

As shown in Table 1, the percentage of product validity of 86.22% is categorized very well, so MathDroid is feasible to use. The result of limited validation is presented in Table 2.

| No. | Statement                                                   | Score |
|-----|-------------------------------------------------------------|-------|
| 1   | The image/animation is interesting                          | 18    |
| 2   | The image/animation is clear/not blurry                     | 18    |
| 3   | The color combination is interesting                        | 17    |
| 4   | The text is tangible                                       | 18    |
| 5   | The text helps clarify the image/message                    | 18    |
| 6   | The usage instructions can easily be traced and understood  | 19    |
| 7   | The material is complete in accordance with the scope of media | 18    |
| 8   | The material is easy to understand                          | 18    |
| Total|                                                             | 144   |
|      | Percentage                                                 | 90%   |

As Table 2 shows, the percentage of MathDroid validity was 90% or categorized very good. It means that the media was feasible to use.

3.4. Implementation phase

MathDroid was tried out at SMP Negeri 1 Babakancikao, Purwakarta in four classroom meetings with 57 eight graders of Class VIII A and Class VIII B. They were very enthusiastic and motivated to learn the properties of cubes and cuboids.

3.5. Evaluation phase

Based on observations, students were able to use the developed MathDroid very well, so no improvement was made to the media. Their mathematical understandings about the properties and elements of cubes and cuboids were also noted.

The results of pretest and posttest revealed that their understanding improved. The gain score of Class VIII A students were 0.62 ≈ 0.6, indicating moderate improvement. The gain score of Class VIII A students were 0.62 ≈ 0.6, indicating high improvement. This result could be said to be very good considering that they only had two classroom meetings.
Students’ attitudes towards the implementation of MathDroid in mathematics instruction is presented in Table 3.

| No | Indicator                                                                 | Class Average Score of Each Indicator |
|----|---------------------------------------------------------------------------|---------------------------------------|
| 1. | Showing fondness for and interest in MathDroid                            | A 3.28                                |
|    |                                                                           | B 3.12                                |
| 2. | Looking motivated for using MathDroid                                     | A 3.17                                |
|    |                                                                           | B 3.09                                |
| 3. | Understanding the instructional material from using MathDroid             | A 3.13                                |
|    |                                                                           | B 3.06                                |
|    | Average                                                                   | A 3.19                                |
|    |                                                                           | B 3.09                                |

Table 3 shows that the average scores of Class VIII A students’ responses was 3.19 and that of Class VIII B students’ responses was 3.09. Thus, it can be concluded that MathDroid received positive responses from students.

The process of MathDroid development followed the five phases of ADDIE; i.e., analysis, design, implementation, and evaluation[10]. The researcher found that MathDroid tended to improve students’ learning interests because smartphones were more interesting than reference books. This smartphone-based media is student-friendly, and its portability ensures that it can be used anytime and anywhere [7],[11]. Students’ achievement in mathematics improved because MathDroid helped them understand instructional materials easily. It’s interesting and easy-to-understand animated display motivated them to learn.

4. Conclusion

Based on the results of validation and revision, MathDroid was considered very good and feasible to use. This application is quite user-friendly and has interesting images and animations. Its portability ensures students to use it anytime and anywhere [6],[12]. MathDroid improved students’ mathematical understanding about properties and elements of cubes and cuboids. This is what an instructional medium is for, making learning easier and helping students do the exercises [7],[13]. Students responded positively to MathDroid, actively participated in the teaching and learning process, were fond of Android-based mathematics instructional media, and, based on the posttest results, demonstrated a good understanding about the instructional materials. It is expected that students become fond of and enthusiastic about learning mathematics. In addition, the use of Android smartphones is not just for gaming and using social media.

References

[1] S. Bhardwaj 2013 Android Operating Systems Int. J. Eng. Technol. Manag. Res. 11 147–150
[2] S. Grover 2013 Using a Discourse-Intensive Pedagogy and Android’s App Middle School Students 723–728
[3] L. Gu, J. Wang and I. Science 2014 ok m Onl ad in e b e V y er th si is on fil O e i n s I ly . m Onl ad in e b e V y er th si is on fil O e i n s I ly . 9 4 187–198
[4] Dubey 2014 Android Operating System http://ijetmr.org/Publication/VIII/IJETMR_VIIIIT25.pdf. 1 1
[5] N. Council, M. Q. What and N. P. Strategic 2015 Strategic Use of Technology in Teaching and Learning Mathematics 2009–2010
[6] NM Astiti 2015 Analisa dan perancangan aplikasi pembelajaran matematika berbasis android in Konferensi Nasional Sistem & Informatika 982–991
[7] S. Goundar 2011 What is the Potential Impact of Using Mobile Devices in Education in Proceedings of SIG GlobDev Fourth Annual Workshop, Shanghai, China 30
[8] R. Kariadinata 2007 Desain dan Pengembangan Perangkat Lunak (Software) Pembelajaran Matematika Berbasis Multimedia 56–73
[9] C. H. Iwen and H. G. Hwang 2014 Efficacy, motivation, anxiety, and achievements J. Comput. Educ. 1 151–166
[10] N. Aldoobie 2015 ADDIE Model *Am. Int. J. Contemp. Res.* **5** 6 68–72
[11] S. Higgins, Z. Xiao and M. Katsipataki 2012 *The Impact of Digital Technology on Learning: A Summary for the Education Endowment Foundation Full Report*
[12] K. B. Lee and R. Salman 2012 *The Design and Development of Mobile Collaborative Learning Application Using Android* **1** 1 1–8
[13] A. R. Nana Sudjana 2011 *Media Pengajaran*. Bandung: Sinar Baru