Developing a multimedia-based learning media for learning matrix transformation

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Abstract. The development of science and technology has entered the world of education. One of the effects is multimedia. The purpose of this study was to develop multimedia-based learning in the transformation matrix learning class XI. After the development, the validity and feasibility tests were carried out by material experts, media experts, and learning practitioners and students. This study uses the Research and Development (R & D) method. There are 6 stages that must be passed, including the analysis phase, the planning stage, the development stage, the validation stage, the verification stage, and the final stage with the name TaGeo. It was obtained that the developed media was feasible to be used as a medium for learning mathematics based on validation by experts and student responses. The results of the validation by material experts showed that the media developed was variable with score of 3.53. The results of the validation by media experts showed that the media developed was valid with score of 3.49. The results of validation by learning practitioners show that the media developed is valid with score of 3.44. And the results of student responses show that the media developed is feasible with score of 3.41.

Keywords: learning media, multimedia, mathematics learning, transformation

1. Introduction
Education is a system that aims to form a smart, noble, and quality person. In Law No. 20 of 2003 explained that education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have spiritual spiritual strength, self-control, intelligence personality, noble character, and skills needed by themselves, society, nation, and country. The meaning of education for some people is the effort to guide children to become adults.

The development of science and technology is increasingly rapid today. This has an impact on all areas of life, for example, laptops that can be used for typing, editing images and videos, playing movies and so on that were not found before. Technological developments have also been applied to the field of education. Already many developed countries are using technology media for the benefit of learning because by using technology assistance, learning will be more focused in explaining abstract objects in mathematics.

The Ministry of Education and Culture (Kemendikbud) states that there has been a decline in the national exam (UN) average grades in high school or the equivalent of the 2017/2018 academic year. This decline occurred in the subjects of Mathematics, Physics, and Chemistry. Totok Suprayitno, as the Head of the Ministry of Education and Culture’s Research and Development Section explained the results of the analysis that the decline in UN scores was caused by two factors. First, there is a high thinking order skill (HOTS).Second, it has not been stated that the change in the paper based UN (UNKP) model to computer based (UNBK) has a significant effect on the value obtained. This change
in model affects the results of the National Examination at the level of the equivalent high school in Indonesia[1].

Following is the table of results of the National Examination of Muhammadiyah 1 Surakarta High School National Examination taken from the Ministry of Education and Culture from 2015 to 2017[2].

| Subjects     | 2017  | 2016  | 2015  |
|--------------|-------|-------|-------|
| Mathematics  | 47.52 | 52.06 | 54.68 |
| Physics      | 50.95 | 51.85 | 64.48 |
| Biology      | 56.71 | 59.74 | 51.61 |
| English      | 58.20 | 54.81 | 65.64 |
| Chemistry    | 75.63 | 47.86 | 54.49 |
| Indonesian   | 79.12 | 69.94 | 80.39 |
| **Average**  | 60.08 | 56.04 | 61.88 |
| **UN Model** | UNBK  | UNBK  | UNKP  |

Based on the table 1 above, it can be concluded that the value of the Mathematics National Examination from 2015 to 2017 is low. In 2017 the value of the Mathematics National Exam was ranked the lowest among other subjects tested. This shows that besides mathematics has a high level of difficulty, the interest in learning mathematics is also still low at the school. Although mathematics is considered to have a fairly high level of difficulty, but each person must study it because mathematics is a system for solving problems in everyday life.

Multimedia-based learning media is one form of development of science and technology that can be used to support teaching and learning activities. Multimedia is text, images, graphics, sounds, and video animations that are combined into one product and can be displayed on an LCD or Projector.

According to Gayeski[3] “Multimedia is a system of interactive communication relationships through computers that are able to create, store, move, and reach back data and information in the form of text, graphics, animation, and audio systems”. Schurman defines multimedia as a combination of graphics, animation, text, video and sound in a complex form that emphasizes interaction between users and computers. Computers that have devices are used to convey multimedia devices or also known as multimedia computers[4].

The presence of multimedia-based learning media can improve the quality of education. In addition, the use of multimedia-based learning media in mathematics learning activities can generate motivation and interest in student learning independently and the achievement of the objectives of the learning.

The purpose of this study is to develop multimedia-based learning media and test the validity and feasibility of media based on material experts, media experts, learning practitioners and student responses. The subjects of this study were students of class XI MIPA 3 Surakarta Muhammadiyah 1 High School with Transformation material. In this study produce a product in the form of an android-based application and a website named TaGeo (Geometry Transformation). Developing of product using the Adobe Animate CC version 2019.

2. Methods
The method used in study is research and development method. The procedure for developing this research uses the development model of Borg and Gall[5] that has been modified. The procedure for developing Multimedia Based Learning Media consists of 6 stages of development, there are, analysis, Planning, development, verification or FDG (Focus Discussion Group),and validation by experts and students.
The data to be collected in this study consists of two data, namely qualitative and quantitative data. The instrument of data collection in this study was to use the results of observations and interviews, as well as questionnaires. Observation techniques such as this are very suitable for conducting research on the learning process, attitudes and behavior, and others. The media feasibility instrument in the form of a questionnaire was assessed using a Likert scale[6] which was modified into 4 scales to measure attitudes, perceptions, and opinions of a person or group of people about the potential and problems of an object, the design of a product and product that has been developed or created[7].

3. Results and discussion

In the 21st century, almost all daily activities become easier because information and communication technology is increasingly advanced. Technological developments have penetrated into various fields including in the field of education. One product developed is learning using interactive multimedia which can take the form of applications, websites, slide shows, and so on.

TaGeo was created with the aim of introducing technology in learning according to Teacher's needs while teaching Transformation material. This is in accordance with the research from Hosman[8]about projects that introduced technology into the education system emphasizing that there are three transformative concepts of ICT projects in education, namely: the teacher will determine the success or failure of the projects, change takes time, and the teacher needs ongoing support for adopting technology and must be treated as a stakeholder.

TaGeo uses an android platform which is included in the mobile learning system to facilitate learning activities in accordance with the times. In the research conducted by Kearney and Maher[9]about the use of iPad by Teachers in learning Mathematics. Mathematics teachers use their iPad to mediate learning, exploit features of authenticity and personalization in formal and informal settings. This can facilitate learning activities using iPad media that are used to find information about the material to be studied.

Learning media developed in this study are integrated into the system e-learning by publishing TaGeo to playstores and websites to be easily accessed on smartphones or laptops. This is based on research conducted by Alsadhan[10] about the design and integration of multimedia content in e-learning. Learning has changed from a limited number of classrooms to anywhere without time and space. Multimedia is developed and integrated into e-learning systems. This makes classroom learning more interactive and students are able to accept material easily.

TaGeo is made using the help of Adobe Animate CC 2019 software which is a development of Adobe Flash Professional software because the software has complete and easy to use tools. In a study conducted by Astra[11] about the development of an android application in the form of a simulation for high school students. The process of making applications in the form of lab simulations using Adobe Flash Professional CS.5.5 and ActionScript 3.0 for scripting where the application is easy to use for beginners.

The developed instructional media serves to demonstrate its important technological developments in the study of mathematics. Research by Serkan[12] result that the role of technology in advanced calculus learning is very necessary. Technology has an important role in teaching and learning activities in lectures. The use of computational technology can motivate students and help develop the procedural and conceptual understanding of student lectures.

The media developed in this study, TaGeo was developed with multimedia based and neatly arranged according to the storyboard. Research conducted by Yohannes[13] explained that the process of multimedia-based teaching and learning dramatically changes the performance of students in module calculus and numerical methods. The lessons presented in this way are more organized and understood. Multimedia is an effective tool for teaching specialized modules such as calculus and numerical methods which are complicated difficult concepts to understand using theoretical ways of teaching. From these studies it can be concluded that multimedia-based teaching and learning processes are more effective than traditional teaching methods.
Development uses the concept of mobile learning in the hope that mathematics learning will be more effective. Research conducted by Bringula[14] which discusses the effect of mobile learning in mathematics learning explains that there are significant differences in students' mathematical skills before and after using mobile learning. The acquisition of learning reveals that students can get a high level of learning because they use mobile learning. Thus, the use of mobile learning in mathematics learning proved effective for students. Mobile Learning is able to assist students in learning mathematics independently or in groups.

Based on this description, researchers have a new idea to develop multimedia-based learning media integrated with e-learning. A learning media in the form of an android application and the website as an intermediary for teaching and learning activities in Mathematics with the material of Class XI Mathematics Transformation. The steps used in developing learning media use the modified Borg and Gall models. Steps taken include the analysis phase, the planning stage, the development stage, the product verification phase, the product validation stage, and the final stage.

a. Analysis

Based on the results of observations and interviews with Mathematics subject teachers obtained information as follows: (1) Using Class XI Mathematics Book 2013 Curriculum Edition 2017 as a student learning reference book. (2) Learning mathematics generally uses the Slide Show media. (3) Students have not been able to understand the material independently. (4) Students have not been able to interpret abstract material. (5) Motivation in learning mathematics is low. (6) The teacher must repeat the material so that students understand the material being taught. (7) Teachers need media innovation to increase students’ motivation and interest in learning mathematics. Competency Analysis aims to find out the Core Competencies, Basic Competencies, Indicators of achievement of competencies to be published in the media in accordance with the content standards.

b. Planning

Based on the analysis phase, then proceed with the planning stage which includes determining the purpose of the media, determining the intended subject, collecting references, designing the storyboard, determining the material and questions.

c. Development

The development stage is divided into 4 stages, namely the creation of a user interface, coding, product testing, and publication. The results of the development of learning media in the form of an application called TaGeo. Inside TaGeo contains 4 main menus, namely Basic Material, Material, Questions, and Profile Maker. This application is made in accordance with the 2013 Revised Curriculum XI Grade Book 2017. The Transformation material contained in this application is, Translation, Reflection, Rotation, and Dilation. Every material has animation, monologue, and sample questions. Following are the procedures for developing the media.
d. Verification

The finished media was then verified through FDG (Focus Discussion Group) with media experts and material experts. Product verification aims for the media to be developed in accordance with learning objectives and material according to the level of understanding of students. In this stage, there are some inputs from experts, including improving sentences, adding animations, fixing questions, improving animations and adding answer keys.

e. Validation

Media that has been developed will be validated by media experts, subject matter experts, practitioners learning and the students' response to media. Validation results in the form of suggestions, comments, and entries that are used as a basis for revising products.

1) Validation by Material Expert

The material expert here is Ms. Mega Eriska RP, S.Pd., M.Pd. The results of the assessment are as follows.

| Assessment aspects        | Amount of assessment | Average | Statement |
|---------------------------|----------------------|---------|-----------|
| Relevance of Material     | 9                    | 3.33    | Valid     |
| Exercises                 | 7                    | 3.29    | Valid     |
| Linguistics               | 2                    | 3.5     | Very Valid|
| Use                       | 2                    | 4       | Very Valid|

| Conclusion                |                      | 3.53    | Very Valid|

Based on Table 2, information is obtained that the average score of the Expert Material assessment on this media is 3.53 which is in the range $X > 3.4$ so that it can be categorized as "Very Valid". The material contained in the TaGeo is in accordance with the indicators, learning objectives, concepts and definitions that apply. Problem training also matches the level of thinking of students. TaGeo uses everyday language so that it is easily understood by students. In addition TaGeo can increase students' motivation to learn Transformation so that the level of students' understanding of Transformation increases. This is in accordance with the ideal conditions of learning media proposed by Miarsj[15], namely Structure, Accurate, and Useful. At the final conclusion the Material Expert said that the media is feasible to be tested with revisions according to suggestions. Material experts suggest revising again to fix bugs and add answer keys so students can find out the answers to the questions they are working on.
2) Validation by Media Expert
The media expert here is Bapak Naufal Ishartono, S.Pd., M.Pd as Lecturer of Computer-Based Mathematics Learning Media Mathematics Education FKIP UMS.

Table 3. Results of Media Expert Validation

| Assessment aspects   | Amount Of Assessment | Average | Statement    |
|----------------------|----------------------|---------|--------------|
| Software engineering | 6                    | 3.83    | Very Valid   |
| Visual Display       | 8                    | 3.38    | Valid        |
| Linguistics          | 2                    | 3       | Valid        |
| Usage Strategy        | 4                    | 3.75    | Very Valid   |

**Conclusion**: 3.49 Very Valid

Based on Table 3, information is obtained that the average score of assessment by Media Experts is 3.49 which is in the range $X > 3.4$ so that it can be categorized as "Very Valid". This is in accordance with the application that was developed creatively and innovatively in accordance with the development of science and technology by means of easy use and can be used repeatedly. The display uses colors and contrasting images so that it can be seen by students accordingly. Language is easy to understand because it uses everyday language. In addition, the media can increase students' knowledge about Transformation and evaluate it with the questions given. This is in accordance with the ideal conditions of learning media proposed by Miarso[15], namely Visible, Interesting, and Useful. At the final conclusion, Media Experts said that the media is feasible to be tested with revisions as recommended. Media experts suggest the media be revised again to fix bugs in the TaGeo application.

3) Validation by Learning Practitioners
Validation was carried out by Ms. Citra Dewi Sekarningtyas, S.Pd as Mathematics Subject Teacher in class XI MIPA of Muhammadiyah 1 High School in Surakarta. Following are the results of validation from Learning Practitioners.

Table 4. Results of Learning Practitioner Validation

| Assessment aspects     | Amount of assessment | Average | Statement    |
|------------------------|----------------------|---------|--------------|
| Relevance of Material  | 6                    | 3.67    | Very Valid   |
| Exercises              | 4                    | 3       | Valid        |
| Linguistics            | 2                    | 3       | Valid        |
| Use                    | 2                    | 3       | Valid        |
| Software engineering   | 6                    | 4       | Very Valid   |
| Visual Display         | 6                    | 4       | Very Valid   |

**Conclusion**: 3.44 Very Valid

Based on Table 4, information is obtained that the average score of assessment by Learning Practitioners is 3.44 which is in the range $X > 3.4$ so that it can be categorized as "Very Valid". The material contained in the TaGeo is in accordance with the indicators, learning objectives, concepts and definitions that apply. Problem training also matches the level of thinking of students. TaGeo uses everyday language so that it is easily understood by students. Applications that are developed creatively and innovatively in accordance with the development of science and technology by using an easy and can be used repeatedly. The display uses colors and contrasting images so that it can be seen by students accordingly. In
addition TaGeo can increase students' motivation to learn Transformation so that the level of students' understanding of Transformation increases. This is in accordance with the ideal conditions of learning media proposed by Miarsa[15], namely Visible, Interesting, Simple, Useful, Accurate, Legitimate, and Structure. In the final conclusion the Learning Practitioner said that the media is feasible to be tested with revisions as recommended. Learning Practitioners recommend that the media be revised again by adding key answers and giving time limits when working on the questions on the TaGeo application.

4) Test Media Response by Students
   The response test was carried out by 27 students of class XI MIPA 3 Surakarta Muhammadiyah 1 High School. The following are the results of student responses to the media.

| Assessment aspects   | Amount of assessment | Average | Statement   |
|----------------------|----------------------|---------|-------------|
| Software engineering | 3                    | 3.59    | Very Worthy |
| Learning Design      | 5                    | 3.28    | Worthy      |
| Visual Display       | 6                    | 3.36    | Worthy      |
| Conclusion           |                      | 3.41    | Very Worthy |

Based on Table 5, information is obtained that the average student response to learning media is 3.41 which is in the range $X > 3.4$ so that it can be categorized as "Very Worthy". This is in accordance with what is in TaGeo where the media is very creative and innovative. Students can be helped with TaGeo while learning Transformation. And the overall appearance can attract student learning interest. This is in accordance with the ideal conditions of learning media proposed by Miarsa[15], namely Visible, Interesting, and Useful. At the final conclusion the students convey that learning by using the TaGeo Application is very fun and useful. There are a number of suggestions for making the media better, namely adding background sounds and adding answer keys.

![Figure 5. Trials product to students](image)

f. Final
   After carrying out the previous 5 stages, the final results were obtained in the form of TaGeo Application with the subject of Class XI MIPA Transformation with Valid and Decent categories to be used in mathematics teaching and learning activities.
4. Conclusion

Development of multimedia-based learning media with the name TaGeo in the material Transformation class XI MIPA using stages from Borg and Gall which have been modified into 6 stages. These stages include (1) Analysis Phase (2) Planning Phase (3) Development Phase (4) Product Verification Phase (5) Product Validation Stage (6) Final Stage. Based on the results of the validation by material experts obtained an average score of 3.53 which falls into the very valid category. Validation by media experts gets an average score of 3.49 which falls into a very valid category. And the last validation done by the learning practitioner gets the result of 3.44 which falls into the very valid category. Judging from the feasibility of the media by students of class XI MIPA 3 Muhammadiyah 1 Surakarta High School, the results of the average score of 3.41 which fall into the very feasible category. So that it can be concluded that the media developed is feasible to be used in the learning process. Thus TaGeo learning media can be categorized as valid and suitable for use in the learning process.

Reference

[1] G. Awaliyah, “Ministry of Education and Culture: Average High School Mathematics National Examination,” www.republika.co.id, 2018. [Online]. Available: https://www.republika.co.id/berita/pendidikan/edukacion/18/05/08/p8f0zb428-kemendikbud-rerata-un-matematika-sma-turun. [Accessed: 25-Sep-2018].

[2] M. of E. and Culture, “School Level National Exam Results Recap (UN) 2015-2017,” https://puspendif.kemdikbud.go.id, 2018. [Online]. Available: https://puspendif.kemdikbud.go.id/hasil-un/. [Accessed: 25-Sep-2018].

[3] D. M. Gayeski, “Making Sense of Multimedia: Introduction to Special Issue,” Educ. Technol., vol. Vol. 32, no. 5, pp. 9–13, 1992.

[4] R. Renofa, “Multimedia dalam Pembelajaran,” renirenofa.wordpress.com, 2015. [Online]. Available: https://renirenofa.wordpress.com/2015/08/13/multimedia-dalam-pembelajaran/amp/. [Accessed: 10-Oct-2018].

[5] M. P. Prof. Dr. Sutama, Penelitian Pendidikan, IV. Sukoharjo, 2015.

[6] E. P. Widoyoko, Evaluasi Program Pembelajaran. Yogyakarta, 2010.

[7] Sugiyono, Metode Penelitian Pendidikan: Pendekatan Kuantitatif, Kualitatif, dan Litbang. Bandung, 2016.

[8] L. and C. M. Hosman, “Technology , teachers , and training : Combining theory with Macedonia ’ s experience Laura Hosman Illinois Institute of Technology , USA Maja Cvetanoska YES Network Project , EDC / USAID Macedonia,” Int. J. Educ. Dev. Using Inf. Commun. Technol., vol. 9, no. 3, pp. 28–49, 2013.

[9] M. Kearney and D. Maher, “Mobile learning in maths teacher education: Using ipads to support pre-service teachers’ rofessional development,” Aust. Educ. Comput., vol. 27, no. 3, pp. 76–84, 2013.

[10] A. O. Alsadhan, S. Alhomod, and M. M. Shafi, “Multimedia based E-learning: Design and integration of multimedia content in E-learning,” Int. J. Emerg. Technol. Learn., vol. 9, no. 3, pp. 26–30, 2014.

[11] I. M. Astra, H. Nasbey, and A. Nugraha, “Development of an android application in the form of a simulation lab as learning media for senior high school students,” Eurasia J. Math. Sci. Technol. Educ., vol. 11, no. 5, pp. 1081–1088, 2015.

[12] C. G. Serkan, “The Integration Of Computing Technology Into Undergraduate Mathematics Classes,” Int. J. Innov. Educ. Res., vol. 3, no. 5, pp. 149–162, 2015.

[13] H. M. GebreYohannes, A. Hadi Bhatti, and R. Hasan, “Impact of multimedia in Teaching Mathematics,” Int. J. Math. Trends Technol., vol. 39, no. 1, pp. 80–83, 2016.
[14] R. P. Bringula, J. N. Alvarez, M. A. Evangelista, and R. B. So, “Learner-Interface Interactions with Mobile-Assisted Learning in Mathematics,” Int. J. Mob. Blended Learn., vol. 9, no. 1, pp. 34–48, 2016.

[15] Y. Miarso, Definisi Teknologi Pembelajaran: Definisi Gugus Tugas dan Terminologi AECT. Jakarta, 1986.