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Development of STEM Learning based Android to Improving Students' Logical Thinking Skills

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Abstract: This study aims to determine the feasibility of STEM learning based Android that was developed to increase students' logical thinking skills competence, as well as to determine student readiness with the renewal of learning modes and student responses to the developed learning media. This study uses the type of Research and Development (R&D) research with adapted from Borg & Gall (2007) dan 4-D model procedural. The learning media product being developed in the form of an android application with a STEM approach on Chemistry Science material. The android application used in this research is the Smart App Creator software. The validity of the media and the quality of the learning media developed obtained the results of an assessment are 93% and 92% (Very Good), then received a positive response from students is 90%, Furthermore the media was developed should be improve logical thinking skills and significantly with a comparison of the average value of the pretest score of 27.04 and posttest of 73.5 to learning outcomes.

Keywords: STEM Learning; Android, Logical Thinking Skill; R&D

Introduction

Education must be in line with the quality of educators as well as adequate facilities and infrastructure in order to realize education and create a quality and quality generation, in accordance with the paradigm shift in the direction of education towards technology. Based on Ministerial Regulation ("Permendikbud 109 /2013") concerning the Implementation of Distance Education (Pendidikan Jarak Jauh/PJJ) in Higher Education, and "Permendikbud 119/2014" concerning Implementation of PJJ for Elementary and Secondary Education, PJJ aims to increase the expansion and equitable distribution of access and facilitate services ranging from basic education to secondary education, with open characteristics, independent learning, complete learning, using educational information and communication technology, and using other educational technologies.

In this regard, all areas of life will lead to digitalization, especially with the current Covid-19 pandemic situation. The global outbreak of Covid-19 that has hit the world, as well as in Indonesia, has caused stay at home and physical and social distancing programs to be implemented as an effort to suppress the expansion of Covid-19. This has hampered the face-to-face (conventional) learning process, so that the digitalization of education cannot be ignored anymore. In accordance with government recommendations through the Ministry of Education and Culture in Circular Letter ("SE 2/2020") concerning Prevention and Handling of Covid-19 within the Ministry of Education and Culture and Circular Letter ("SE 3/2020") concerning Prevention of Covid-19 in Education Units.

Furthermore, the Ministry of Education and Culture's policy of "Merdeka Belajar" and "Kampus Merdeka" inspired researchers to support the program through innovation of the PJJ mechanism in accordance with these policies, with 3 keywords, namely "Student Interest", "Content Creator" , and "Competency Based Assessment" which is applied in the form of android and can be accessed by gadgets, be it PC, laptop, tablet or mobile phone. as the current development of education has entered the realm of Education 4.0 fit for Industry 4.0.

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STEM is an approach in the development of the world of education that integrates more than one discipline, such as science, technology, engineering, mathematics, and cross-disciplinary combinations of the diferent STEM disciplines. Integrative STEM education is very effective way to engage students in higher-order critical thinking and problem solving skills by placing rigorous mathematics and science in the context of technology and engineering (Li, 2014; Li et al., 2020; Hayden et al, 2011; Setiawaty et al., 2018), and STEM educated student is a problem solver, logical thinker, technologically literate, and able to relate his own culture to the learning (Morrison, 2006). The integration of Android-based digital STEM learning is expected to solve various challenges, namely overcoming the limitations of experiments in science learning, as well as increasing logical thinking skills and cognitive aspect, where students can learn independently to solve problems and improve their logical thinking by utilizing various innovations that were born in the era of the industrial revolution. 4.0 such as internet on things, artificial intelligence, big data, and robots to improve the quality of human life (Sugiyarto, et al, 2018; Setiawaty, et al, 2020).

Furthermore, the integration of art and design into STEM allows for more human-centered innovation, ensuring that technological development is responsive to the needs, desires, and challenges of users (Chen & Lo, 2019). Android-based digital STEM can also e interpreted as a human and technology-centered learning concept. Tsai and Tsai (2020) examined digital game-based science learning efectiveness. Studies conducted by Tokac et al., (2019) and Hung et al., (2014) found that effects of video games on students significantly more positive impacts than traditional instructional methods. They also studied the moderation effects of grade level, instrument type, length of game-based intervention, country, publication type, and study year characteristics on learning achievement.

Method

The research and development procedure carried out is an adaptation of the Borg & Gall (2007) and 4-D (*Define, Design, Development,* and *Disseminate)* procedures (Thiagarajan, et al., 1974), and will be implemented in junior high schools in North Aceh Regency and Lhokseumawe City.

The data analysis technique used is to determine the assessment of media quality and improvement of logical thinking skills and learning outcomes. The data obtained in the form of qualitative data is converted into quantitative with criteria for the category of ideal assessment scores.

Result and Discussion

The development of the STEM learning based android refers to the logical thinking skills competency demands in the Merdeka Curriculum, with the following results.

Defining Stage

At this stage an initial analysis is carried out to see the needs of students and adjust to the needs of students and school conditions (*front analysis*). Furthermore, a learner analysis, task analysis, concept analysis and specifying instructional objectives was also carried out design STEM learning media to match competencies and learning outcomes based on the Decree of the Minister of Education and Culture of the Republic of Indonesia ("958/P/2020") concerning Learning Outcomes in Early Childhood Education, Basic Education, and Secondary Education.

Designing Stage

Design is carried out for design before development by planning the outline before developing the product, through constructing criterion–referenced test, Media selection, Format selection, and initial design.

Development Stage

This stage consists of expert appraisal and developmental testing by focusing on validating, reviewing and assessing the feasibility of designing android STEM learning media products, The following is the percentage of assessment results obtained from material expert validators and media experts.

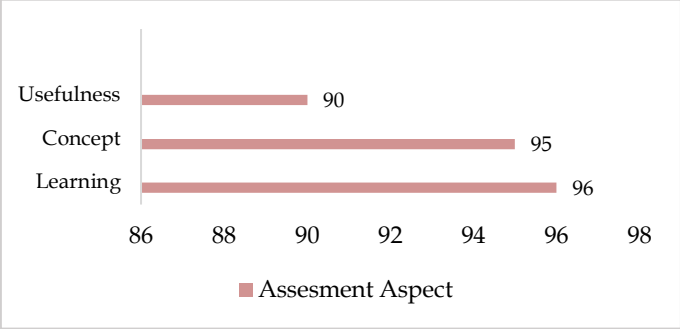

Figure 1. Percentage of material expert assessment validation results chart

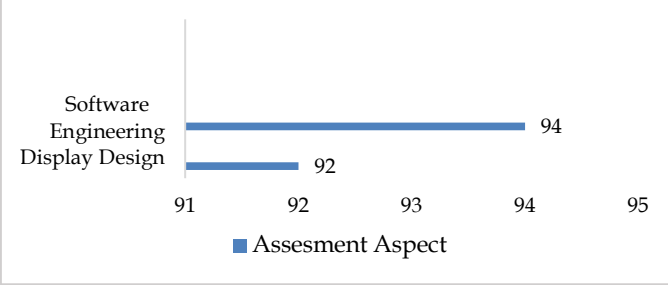

Figure 2. Percentage of media expert assessment validation results chart

Dessemination Stage

This stage includes validation testing, packaging, diffusion and adoption. The product that has been revised at the development stage is then implemented for students to be asked for their responses and a feasibility test by teachers who teach science.

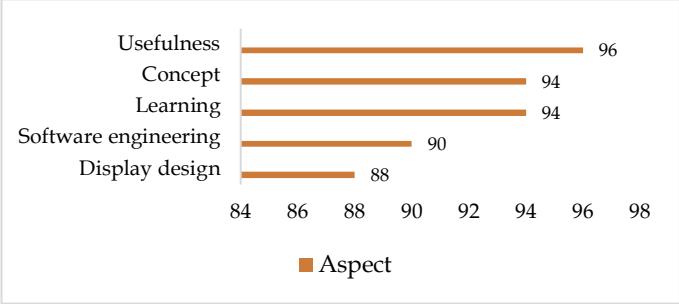

Figure 3. The graph of the results of the media quality test by the teacher

In addition to assessing, the teachers also provided input on the developed learning media products, namely the need for additional media content because the material in the curriculum (Kurikulum Merdeka) was very limited. Furthermore, the results of student responses can be presented as follows.

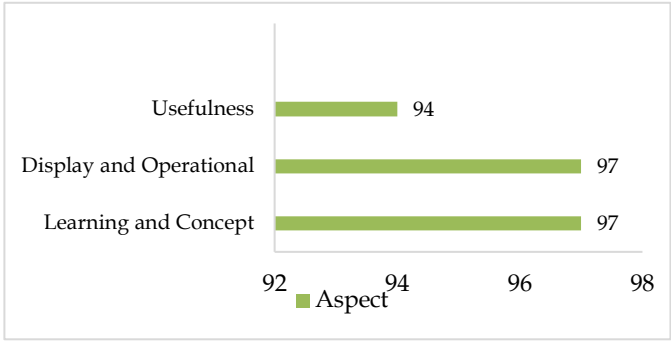

Figure 4. The graph of the student's responses

The media is also designed using smart app creator software by paying attention to the content and learning outcomes as well as the results of reviews and input from teachers and validators. Futhermore, digital games can efectively promote and enhance students' learning achievement in STEM education, enhancing our understanding of the application and practice of digital games in STEM education (Wang et al., 2022).

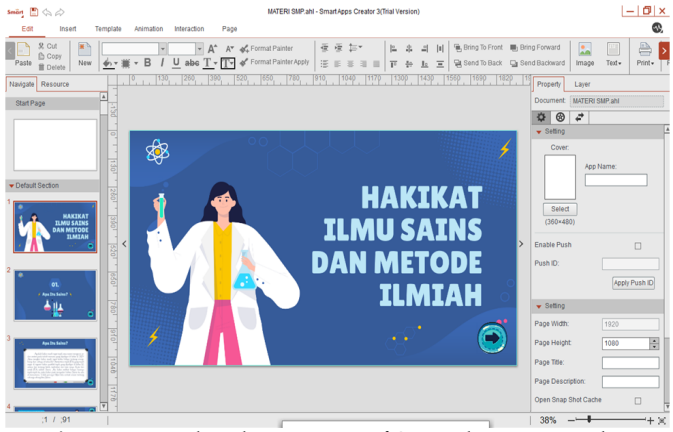

Figure 5. Display the contents of STEM learning media

Table 1. Students' pretest and posttest scores

Pretest		Postest		<g>	Category
Average value	Completeness (%)	Average value	Completeness (%)		
27.04	0	73.5	71	0.63	Medium

Based on the results obtained the application of the developed media is also able to have a significant influence on students' cognitive learning outcomes with 71% completeness. In addition to the primary objective of increasing students' logical thinking skill in STEM. Furthermore, researchers have noted that digital games can achieve diversified STEM learning goals that enhance students' learning motivation, reduce their anxiety, and indicated that it improvement of flow experience, creative confidence, social constructs and their understanding of knowledge concepts, and cultivate their problem-solving abilities (Hwang et al., 2012; Hung et al., 2014; Gu et al., 2022; Kijima et al., 2021).

Conclusion

Based on the results of the study, it can be concluded that the Android-based STEM learning media which was developed using the 4-D development model, has the quality of the media in terms of expert validation and the responses of teachers and students who are included in the qualifications are very suitable to be used as learning media in measuring logical thinking skills and student cognitive. Furthermore, it is hoped that there will be improvements to the learning media that have been made by researchers by optimizing the use of media widely.

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