Junior secondary school teachers and students’ needs for the use of digital comics in learning mathematics

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Abstract. Digital comics are media presented in the form of visual images that can raise students’ motivation and interest in learning. In Indonesia, it is difficult to find comics relevant to mathematics learning and very few international journals discuss comics in mathematics learning. The purpose of this study was to develop digital comics as a medium for learning mathematics in junior high schools. This study is an early stage of developmental research using the ADDIE model, that is, analysis stage. In this stage, the needs of teachers and students towards the development of digital comics as a medium for learning mathematics were analyzed. Participants in this study involved three mathematics teachers, three vice-principals of curriculum and six students from three junior high schools in Banda Aceh with high, medium, and low national exam scores. Data were analyzed by using a descriptive qualitative method. The results showed that students were less interested in learning mathematics. Moreover, all teachers and students responded positively to the need for developing digital comics as a medium for learning mathematics. The study findings indicate that it is necessary to conduct further research on the development of digital comics as a medium for learning mathematics.

1. Introduction
Learning media is one of the most critical factors that can influence student learning outcome because media can deliver ideas of learning in accordance with learning objectives. Learning media can be used to motivate, assist, and guide students for independent learning, self-discovery and self-actualization. Learning media can accommodate the needs of a wide range of learners [1]. Schools should be equipped with learning media. Regarding learning media, it is important to take into account its characteristics in designing learning instructions, including the media that can be applied in a mathematics classroom.

One of the media that can be used in learning is comics. Comics are media that consist of fiction and non-fiction ideas conveyed through visual images, including cartoons, designed to create humour in order to deliver the essential part of comics [2]. The comics can enhance and enlarge communication by facilitating readers to create their understanding [3]. In this era, limited number of comics in the mass media are explicitly scientific [4,5]. For mathematics teachers, it is challenging to find comics relevant to mathematics concept. It addition, there is limited study on comics for learning mathematics while most of the previous studies explored the use of coming in teaching and learning of science and language. Even though Comics provides another way of looking at abstract mathematical concepts [6]
There are many types of comics; one of them is digital comics. In Europe, there is an EduComics.org project organization that aims to demonstrate how web-based comics can be used in the classroom to improve the learning process, engage and motivate students, and use technology effectively. This is in accordance with the use of digital comics that allows students to be able to experience more authentic situations and acquire more knowledge through comics [7].

Algebra is one of the mathematics subject that can be presented in comics. Algebra is not only as a language of science, but also as a gateway to advanced mathematics and higher education. Algebra is a difficult topic not only for students to learn but also for teachers to teach [8-10].

The previous study conducted in Singapore found that comics and cartoons could increase students’ motivation and interest, especially in learning mathematics [11]. Another study, conducted in Turkey for science classroom, revealed that comics could assist learning and make it more enjoyable [4]. On the other hand, in Indonesia, there was a study on the development of comics as biology learning media showing that comics could improve learning outcomes, increase students’ activities and interest, and bring positive responses from students as well as teachers [12]. Regarding the previous study, we argued that it is necessary to develop digital comics as a mathematics learning media that could be applied in students' daily life. Based on the rationale, the present study intends to answer the following research questions: First, what are the characteristics of students towards mathematics learning? Second, what are the teachers and students’ responses to the use of media in mathematics learning? Third, what are the teachers and students’ responses to the use of digital comics as a media in the mathematics classroom?

2. Method
The present study is a Research and Development study utilizing the ADDIE development model. ADDIE is a concept of product development that creates performance-based learning and aims to make intentional learning student-centred, innovative, authentic, and inspirational [13]. ADDIE stands for analyse, design, development, implementation, and evaluation.

| Table 1. Description of ADDIE development model phases |
|-----------------------------------------------|
| ADDIE Phase | Concept |
|-----------|---------|
| Analyse   | Identify problems |
| Design    | Verify the desired performances and appropriate testing methods. |
| Development | Produce and verify learning resources |
| Implementation | Prepare learning environment and engage students. |
| Evaluation | Evaluate the quality of products during the learning process, before and after implementation. |
Figure 1. Research Design

Based on Figure 1, the researchers develop digital comics according to the ADDIE model. However, in this paper, the researchers only present findings on teachers and students’ responses towards the development of digital comics as a media of mathematics learning. To analyse the responses, the researchers used qualitative narrative method that aims to make sense of a phenomenon based on participants’ point of views [14]. The subject of this study were vice-principals, teachers and students from three junior high schools in Banda Aceh which were categorized into three levels: high, medium and low. These levels were based on national exam scores the schools achieved in 2018. Teachers and students’ responses were obtained from three teachers, three vice-principals of curriculum and six students. This technique was employed so that the subjects could represent public junior high schools in Banda Aceh, in collecting data, researchers utilized the same approach using sound recordings and then made a transcript by playing back the recorder several times. Thus, the researchers believed this study would be valid and reliable.

3. Results and discussion
The interview was conducted in three schools. Each school involved one teacher, one vice principal of curriculum and two students. Teachers were given 14 questions consisted of six items related to the students’ characteristics towards learning mathematics at school, four items focusing on learning media used in mathematics learning and another four items related to the use of digital comics at school.

3.1. Teacher’s responses
The three subject teachers argued that students’ performance in mathematics was still poor; they faced difficulties in learning mathematics and were not interested in mathematics. One of the teachers
claimed that rather than staying in the classroom during lesson, some students chose to leave the classroom going to the bathroom and so on. This happened when classroom rules were not strict.

Many factors caused students to be less interested in learning mathematics. According to one of the teachers, one of the factors was the teachers themselves, if teachers were less innovative in teaching and did not support the 21st-century skills. Whereas, teachers should have knowledge of technology, pedagogics and content [15]. Another teacher believed that family was also another factor that contributed to students’ interest in learning. Lack of motivation to learn mathematics and limited knowledge to access mathematics reading resources made students less interested in learning mathematics.

Regarding the learning media, the interview results showed that the three teachers still used conventional media, such as manipulatives and PowerPoint. Not all mathematics topics were taught using learning media. For instance, algebra was taught conventionally using the blackboard. The teachers taught in such the way due to lack of relevant learning media and time constraints. Algebra is a topic that is difficult not only for students to learn but also for teachers to teach [8,9,10]. Using media in teaching mathematics is highly recommended because learning media can enhance students’ experience so that it helps students integrate their prior knowledge and their new abstract knowledge [16].

Another finding related to teacher responses to the use of digital comics as a learning media was that one of the teachers had heard that comics were used as instructional materials, but it was in science classroom, not in mathematics; while the rest of the teachers did not know if comics could be used for teaching materials. All of the teachers strongly agreed that comics could be used as media in learning mathematics since the visual images in comics could motivate students to learn mathematics, especially if the comics are attractive and contain mathematical knowledge.

The teachers stated that digital comics could be implemented at school, even though the government regulations do not allow students to carry smartphones in the school area. They can use smartphones and laptops during the lesson only if they get permission from the school. However, the implementation of digital comics takes time because some students do not have smartphones or laptops.

During the interview, the researchers asked the vice principals nine questions related to the use of learning media provided by the schools in the mathematics classroom. All of them agreed that teachers had been prepared to teach using learning media since every year several teachers representing the schools participated in trainings related to learning media, such as, GeoGebra training. However, the teachers still commonly used conventional media, such as, manipulatives and PowerPoint. Although computer lab and internet were accessible, the teachers preferred to use a laptop and a projector in the classroom. Finally, the three vice-principals of curriculum responded positively to digital comics as media for learning mathematics.

3.2. Student’s responses
To collect data from students, the researchers provided 12 questions in the questionnaire that contained four questions about mathematics learning at school, four questions about media of learning mathematics, and four questions related to the use of digital comics at school. Five students from the three schools encountered difficulties in learning mathematics. It was because mathematics was abstract, but teachers lacked innovative strategies to make it less abstract and also mathematics reading materials were limited. All of those factors influenced students’ interest in learning mathematics. In addition, four students argued that their teachers did not use learning media during mathematics classroom; the teachers taught the lesson traditionally. In relation to the use of digital comics, five students from the three schools like reading comics, but only one of them knew that learning material can be presented in the comic form because the student subscribes to e-learning. All students were very enthusiastic about the application of digital comics as learning media because they got more interesting reading materials.
There is a contradiction in the vice principals and the students’ responses. The vice principals stated that teachers had been prepared to use learning media through trainings, while students argued that the teachers did not use learning media during the lesson as in algebra topic. Teachers only used learning media for certain topics such as geometry.

Based on the results from the questionnaire and interview, it can be concluded that students and teachers agreed with the development of digital comics as a medium of mathematics learning because the visual images arranged into a story in comics can increase students’ interest and motivation [11, 17, 18]. Nevertheless, lack of teachers’ knowledge of using media relevant to mathematics forced them to teach conventionally and make use of common media only, such as, PowerPoint and manipulatives. As a result, the students’ interest and motivation decreased. Finally, the findings of this study imply that there is a need for further research on the development of digital comics as a medium for learning mathematics.

4. Conclusion
Data analysis from the interview revealed the students’ performance towards mathematics were that students were less interested in learning mathematics. Another finding showed that teachers tended not to use learning media in the mathematics classroom. In regard to the importance of digital comics as a medium of mathematics learning, this study found that two subject teachers did not know that mathematics teaching materials can be presented in the form of digital comics. All teachers and students responded positively to the need for developing digital comics as a medium of mathematics learning. All teachers believed that digital comics can be integrated in the classroom, but one teacher argued it would take time for the implementation. The study also suggested that the availability of digital comics as a media for learning mathematics was still limited. Thus, digital comics as a media of mathematics learning need to be developed. Moreover, this study also showed that it is necessary to conduct further research on the development of digital comics as a media for learning mathematics. The next step that needs to be conducted is to analyse the whole stages that include curriculum analysis, concept analysis, content analysis, and media analysis. After that, the design, development, implementation, and evaluation phases will follow.

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