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Android-based Physics Comic Media Development on Thermodynamic Experiment for Mapping Cooperate Attitude for Senior High School

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Abstract. The research is aimed to (1) produce a physics comic based android on thermodynamic experiment suitable for use in learning (2) know the cooperate attitude mapping of senior high school with physics comic. This study used the 4D Model development model. In the Define stage to define the problem. Design stage to design physics comic learning media. Develop stage to validation of product draft by validators and learning experiments. The data obtained were analyzed quantitatively. Instrument validity is calculated using Content Validity Index (CVI). The results showed that (1) Media of physics comic developed suitable for use in learning, (2) Students cooperate attitude mapping when implementing and modelling class in thermodynamic material based on observation and questionnaires were categorized as good for all students.

Keyword: Physics Comic; Research Development; Cooperate Attitude Mapping

1. Introduction

In this era teacher have been using the media as a teaching tool. But in the reality illustrates that the use of media combined with technology is considered not maximal applied because it takes a long time so it's rarely used [1],[2]. Teachers tend to use lecture methods when teaching. This does not involve student activeness and enthusiasm for learning seems low so that negative attitudes arise towards learning physics [3],[4]. In addition, students have a tendency to memorize various types of symbols and physics equations without knowing the relevance of these equations in physics learning because the teacher introduced the concept along with giving example of the problem [5]. Teachers also have not utilized the learning media that exist in schools, namely the internet and the possessed devices of students [6]. When teacher explain the material states that students are busy with peers playing games, social media in smartphone that disrupt learning concentration, decrease academic performance and reduce productivity [7-12]. When used properly, in fact the media will facilitate communication, smartphone makes learning efficient and easy [13]. The use of smartphones as a trend in learning styles today can make learning more real, efficient and easy to do without discriminating in learning [14],[15]. For that, it is unfortunate if the smartphone is not involved in learning [16].

In learning especially physics, various sources of learning offered teacher one of them through comics. Students are more interested in using comics that contain images than printed books as the main source of learning [17], [18]. Comics can encourage creative and original ideas of readers, clarify the teaching materials students worksheet commonly used in the classroom to make learning more fun [19],[20]. Comic media itself has become a trend for most students in the world, especially Asia [21]. Although the comic media is expected as a medium of comprehensive science communication in addition to presenting only images, but in its development media comics are still rarely used in learning



[22]. Comic media was originally available only in print, but in the current era can easily be accessed by smartphone in web content [23].

The current era of learning implements the 2013 curriculum. It's facilitates student learning. However, in some school's experiment activities are rarely carried out in learning physics [24]. Through experiment activities it is expected that students can work in groups to achieve learning goals with specific roles specified [25], [26]. The application of learning media innovations needs to be done by laying out the collaborative attitudes of students. To that end, to increase the active student involvement, then developed the physics learning media in the form of comic based on android. Learning is done in the form of a group practice using the application *Himawari Reader* on comprehensive thermodynamic material (explanation of material concepts in form of formulas, drawings, or verbs, sample questions, and practice questions) and there are instructional videos, as well as experimental samples. Assessment of group assessments conducted with experiments, giving questions to discuss with each group, and each representative of the group forward to work on the problem and presented the results of the experiment. It shows the success of group learning in mapping the cooperation attitude of each student

The rest of this paper is organized as follow: Section 2 presents literature review. Section 3 describes the proposed research method. Section 4 presented the obtained results and following by discussion. Finally Section 5 concludes this work.

2. Related Works

The use of media in learning deliberately done to facilitate convey a message that can increase one's willingness in learning, achieving learning goals, cultivate learning motivation, clarify teaching materials, and vary teaching method [27-29]. TPACK is a form of knowledge that emerges that transcends the three core components (content, pedagogy, and technology). The importance of developing TPACK by teachers to understand and overcome contextual factors from the use of tablet computers in education for effective teaching with technology [30], [31].

Comics are fun, easy-to-read entertainment media, and provide important information and can be used as independent teaching materials [32],[33]. Lin [34] explains that comic books feature humour, narrative, and visual representation as well as potential media for science communication [35]. Hadi [36] reveals that comics in the form of mobile apps also allow paper saving, especially comics in the form of applications like this can have more than one feature, which is available online tests, animations, and materials. The presence of visualization of images in comic books makes science communication easier to understand. [34].

Learning by using smartphones make it easier for students because it can be done anytime and anywhere [37]. Learning with smartphones adjusts the situation and circumstances of the wearer. In facilitating and alleviating teacher teaching [38]. The smartphone app connects people directly or indirectly through social media [10]. Smartphones can provide access to comprehensive information regardless of social status, residence, and culture [39]. Various studies have succeeded in applying smartphones in science, social, language, economics, geography [40]. So, it can be said that the comic media used on android can improve the quality of learning.

Cooperation is a process of working together with others to achieve the desired goals. Collaboration is also a part of social skills between friends, communicating, sharing knowledge, and giving praise to children will make children can communicate with friends and receive other responses [41]. Soekanto [42] added the principles of cooperation are: (a) Children see clear, meaningful purpose, plan, and problem for them, (b) Each member contributes their respective thoughts, (c) Every individual feels responsible to (e) Used democratic procedures in planning, completing, and making decisions, (f) Leaders can create an atmosphere in which everyone wants to contribute their thoughts and cooperate cooperatively, (d) Children participate and work effectively with other individuals g) Used assessment of group progress in terms of: social, leadership, activity, (h) causing constructive change in one's behaviour.

3. Proposed Methodo

This research uses Research and Development (R&D) research method with developed research model is 4D Models [43]. The research consists of defining (Define), Design (Design), Development (Develop) and Dissemination (Disseminate). (1) Defining aims to define and define general requirements in learning. (2) Design by starting to design products developed according to the results of the analysis. (3) Development is the development of product manufacture according to design. (4) Dissemination by broadly introducing development products. However, this research is limited to the Development stage.

The study was conducted in one of the high schools in Sleman Regency, Yogyakarta, Indonesia. The research subjects consisted of 23th grade students of Natural Sciences. Learning is done through experiment activities and group discussions on thermodynamic material, including law 0 Thermodynamics and law 1 Thermodynamics. Learning is expected to help students in understanding material and mapping cooperative attitude through comic learning media. Research on the development of this comic physics media to obtain data in the form of comments and suggestions revision I made by experts. Score value of product quality of comic-based physics comic android, and value of student cooperation ability obtained from revision II after product tested in field. This learning innovation was carried out in 2 treatments, namely in modelling and implementation classes. The modelling class was conducted on Thursday, April 19, 2018 by researchers. While the implementation class is on Thursday, April 26 2018 by physics subject teachers.

Data analysis used are qualitative and quantitative analysis. Qualitative analysis aims to revise the product based on validator suggestions. The quantitative analysis used to determine the validity and reliability of research instruments and feasibility of comic media developed. To determine the validity of RPP (Learning Process Plan), worksheets, physics comic media were analyzed by using Content Validity Ratio (CVR) and Content Validity Index (CVI). Scoring on validation questionnaire with CVR. Lawshe [44] stated the CVR value is determined by the equation as follows:

$$CVR = \frac{(N_e - \frac{N}{2})}{\frac{N}{2}} \quad (1)$$

with N_e = the number of validators that agree and N = total number of validators. After identifying each questionnaire with CVR, CVI is used to calculate its validity index with the equation:

$$CVI = \frac{\text{total number of CVR}}{\text{jnumber of item}} \quad (2)$$

Furthermore, determined the length of the interval class in each category consisting of five categories, the grouping of values in each category is presented in Table 1.

No	Interval %	Category
1	$80,01 \geq x \leq 100$	Excellent
2	$60,01 \geq x \leq 80,00$	Good
3	$40,01 \geq x \leq 60,00$	Fair
4	$20,01 \geq x \leq 40,00$	Less
5	$0,00 \geq x \leq 20,00$	Worst

Qualitative descriptive analysis in the form of qualitative data description. Data obtained from the results of observations and questionnaires when learning takes place using products developed in the form of android-assisted physics comics equipped with videos on legal material 0 Thermodynamics and thermodynamic law I. The comic media is created using the *Sigil* application. The comic can be read

through the *Himawari Rider* application on a smartphone. Display of comic products used in modelling activities using law 0 Thermodynamics can be seen in Figure 1. While in implementation activities using Thermodynamics I law can be seen in Figure 2.





Sejenis gas berada dalam wadah yang volumenya 1 liter dan tekanan 2 atm (anggap 1 atm = 10^5 Pa). Tentukan usaha yang terjadi jika: a. gas memuai pada tekanan tetap sehingga volumenya menjadi 2x semula. b. gas dimampatkan pada tekanan tetap sehingga volumenya menjadi setengah kali semula.

$P = 1 \text{ atm} = 2 \times 10^5 \text{ Pa}$ dan
 $V_1 = 1 \text{ liter} = 10^{-3} \text{ m}^3$
 a. Usaha yang terlibat untuk $V_2 = 2 V_1 = 2 \times 10^{-3} \text{ m}^3$
 $W = P \cdot \Delta V = P (V_2 - V_1) = 2 \times 10^5 (2 \times 10^{-3} - 1 \times 10^{-3}) = 2 \times 10^2 \text{ joule}$
 Usaha bernilai positif yang berarti system melakukan usaha terhadap lingkungan



b. Usaha yang terlibat untuk $V_2 = \frac{1}{2} V_1 = \frac{1}{2} \times 10^{-3} \text{ m}^3$
 $W = P \cdot \Delta V = P (V_2 - V_1) = 2 \times 10^5 (\frac{1}{2} \times 10^{-3} - 1 \times 10^{-3}) = -10^2 \text{ joule}$
 Usaha bernilai negatif yang berarti system dikenai usaha oleh lingkungan

- Berapa usaha yang dibutuhkan untuk memampatkan sejumlah gas dari volume 3 liter menjadi 1 liter jika dilakukan pada tekanan tetap 4 atm?
- Suatu system gas berada pada tekanan 5 atm dengan volume 1 liter. Kemudian gas melakukan kerja sebesar 400 joule terhadap lingkungan pada tekanan tetap, hitung volume akhir sisa gas! Sekarang dikerjakan yaa!

Oke Tante... Sekarang Mina coba kerjakan soal itu

Figure 1. Display of comics in modelling class

Hukum I Termodinamika



Apa kalian masih ingat hukum 0 Termodinamika? Coba sebutkan ada berapa hukum dalam Termodinamika?

Ya Pak. Jumlah kalor pada suatu sistem adalah sama dengan perubahan energi di dalam sistem tersebut ditambah dengan usaha yang dilakukan oleh sistem.

Saya kaku yang jawab!

Ya benar. Tapi hanya labirin saja. Proses-proses termodinamika itu ada 4 macam. Ada yang tahu?

Saya baca. Dalam hukum termodinamika, terdapat proses isobarik, isotermik, isokhorik, dan adiabatik. Benar ya Pak?

Ya benar. Tapi hanya labirin saja. Proses-proses termodinamika itu ada 4 macam. Ada yang tahu?

Ya benar. Tapi hanya labirin saja. Proses-proses termodinamika itu ada 4 macam. Ada yang tahu?

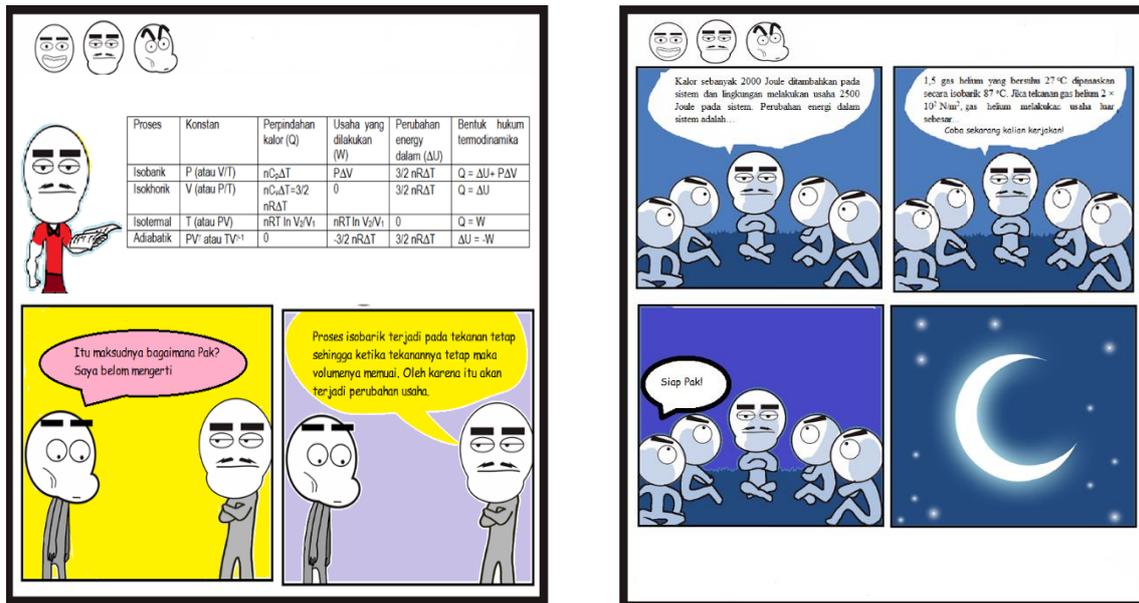


Figure 2. Display of comics in implementation class

4. Result and Discussion

This section presents the results obtained and the following by discussion.

4.1. Result

4.1.1. Media Validation

In the develop stage, the assessment of comic media developed by the validator in Table 2.

Table 2. Expert Validation Result

Device	CVI	Category
Lesson plan	1	Very good/suitable
Student worksheet	1	Very good/suitable
Physics comic	1	Very good/suitable
Questionnaires	1	Very good/suitable
Observation	1	Very good/suitable

4.1.2. Observation

The learning was conducted through practical activities and group discussions which were used cooperative attitude mapping based on observation sheets by observers and questionnaires filled by students themselves. Observation data during modelling class can be seen in Table 3.

Table 3. Cooperate Attitude Mapping Based on Observations during Modelling

	The number of students	Percentage (%)
Very Good	10	43.48
Good	13	56.52
Total	23	100

Cooperate attitude mapping based on observation when applied in the modelling class can be seen in Figure 3.

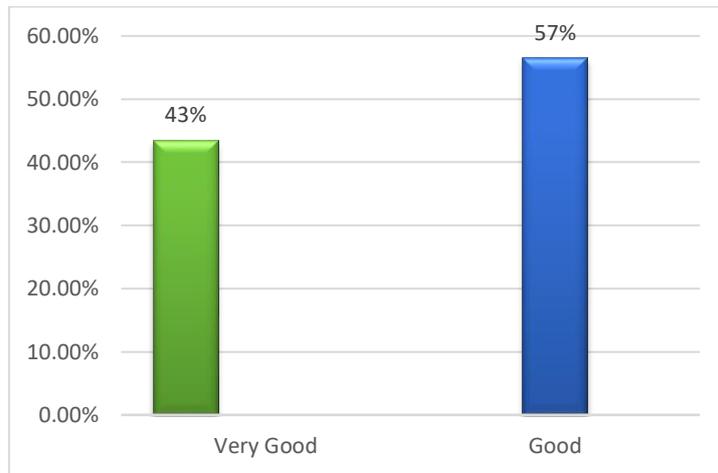


Figure 3. Graph of Cooperate Attitude Mapping Based on Observations during Modelling

4.1.3. Questionnaire

While the data obtained from the results of the questionnaire during the modelling class can be seen in Table 4.

Table 4. Cooperate Attitude Mapping Based on Questionnaire When Modelling

	The number of students	Percentage (%)
<i>Very Good</i>	16	69.57
Good	7	30.43
Total	23	100

Cooperation attitude mapping based on questionnaire when applied in the modelling class can be seen in Figure 4.

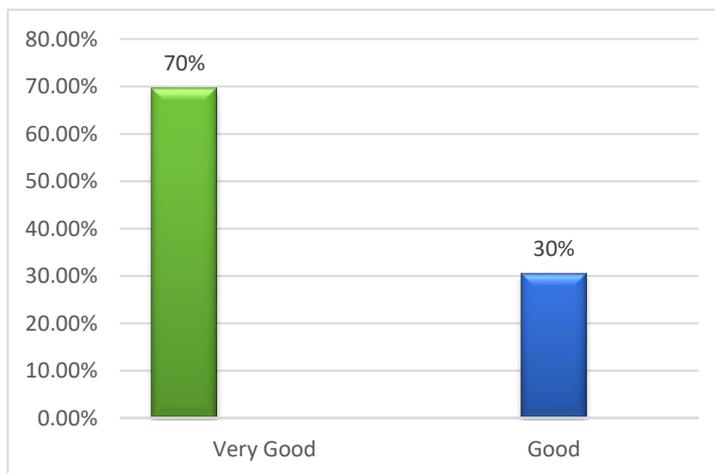


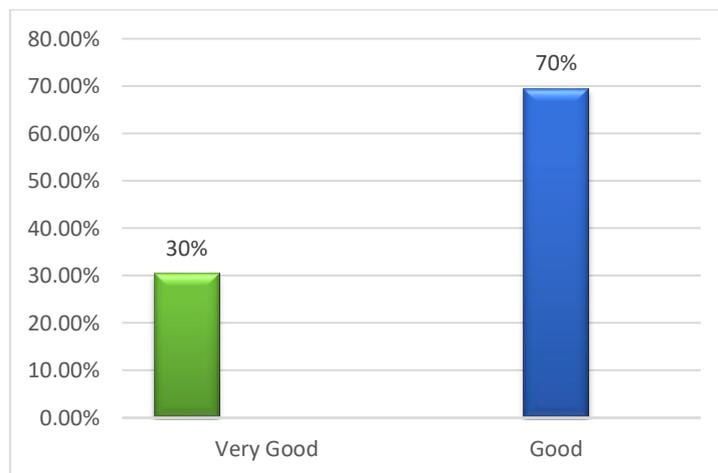
Figure 4. Cooperate Attitude Mapping Based on Questionnaire When Modelling

Cooperation attitude based on observation data in the Implementation class can be seen in Table 5.

Table 5. Analysis of Cooperate Attitude Mapping Based on Observations during Implementation

	The number of students	Percentage (%)
Very Good	7	30.43
Good	16	69.57
Total	23	100

Cooperation attitude mapping based on questionnaire when applied in the modelling class can be seen in Figure 5.

**Figure 5.** Cooperate Attitude Mapping Based on Observations during Implementation

4.2. Discussion

Based on the analysis of expert validation results in Table 1, Lesson plan has a CVI of 1 (very good) so it is feasible to be used in learning on thermodynamic materials. Results of Student Worksheet have CVI of 1 (very good). Media physics comic have CVI of 1 (very good). While questionnaires and observation sheet of cooperative attitude have CVI of 1 (very good). Results of all devices in the development of comic learning media has a CVI value of 1 with very good category, it is said to be suitable for use in physics learning.

The results of data analysis when modelling on the attitude of cooperation based on questionnaires filled with students obtained a percentage of 69.57% very good and 30.43% good. Meanwhile, based on the observation results obtained a very good 43.48% percentage and 56.52% good. The result of data analysis of observational cooperation attitude during the implementation class by observer obtained 30,43% very good and 69,57% good. The cooperative attitude of class XI IPA students is categorized good, because when conducting experiments in the laboratory most students can work together in conducting an experiment as well as discussing when doing the questions in the Student Worksheet (LKS) and the problems contained in the comic. However, there are actually some children who are less enthusiastic in learning, over time some students began to wonder in doing an experiment as in the comic. Thus, they begin to be enthusiastic in carrying out the learning process. Percentage of cooperative attitude values with questionnaires and observation sheets is categorized well for all students. So it can be said that the application of this comic media is considered successful.

In modelling class, comic-based learning media was first applied in the XI Science class. This new media innovation becomes the first experience for students to learn in groups by utilizing smartphones related to the legal material 0 Thermodynamics. Because the first time, the students seem confused and unfamiliar with the activities that must be done when the learning takes place. But with the guidance of the model teacher, the learning took place smoothly. Students read and view the pictures contained in

the comics, so they can imagine the real events that exist in everyday life. Student co-operation is apparent when all members of the group must understand the material submitted and solve the problems contained in the comic and conduct experiments as directed in the comic.

In the implementation class, physics-based comic-based media is the second time held in the same class. The application is carried out in the same class because in the school there is only one class XI IPA, so the material used is sustainable, namely the law 1 Thermodynamics. Students seem more prepared and not confused with what to do when learning the group. Students are more easily conditioned, knowing what to do. Cooperation and enthusiasm of students increases because students realize that with learning using comic-assisted physics android media more fun, so it can improve the understanding of physics by looking at images and text contained in the comic. Teachers appear not ready and master the comic media taught in learning, because the first time high school teacher using android-assisted comic media. So the teacher asked the students what to do next in the learning process. The device has been notified and sent an email to the teacher, one week prior to the implementation of the lesson. In this implementation, there is no technical error because students are better informed about how to operate comics with their devices. Practical activities in the implementation activities are also more lively, because students really try themselves related to the phenomenon of law 1 Thermodynamics is about blowing balloons. This activity is considered new by the students because according to the comments of some students, this activity has never been implemented. Students are more enthusiastic to ask questions and try.

Learning using comic media is considered to provide many benefits. Comics have been used in various fields of educational research and show that comics are effective in the field of education [45]. The comic storyline is more interesting than the LKS (Student Worksheet), so it is effective in preventing student boredom [20]. Experiment activities in the classroom are fun when physics comics are applied in the classroom. Students are more interested in using comic media. Students can see the learning videos contained in the comics, so that the enthusiasm of the students gets bigger.

Communicate the results of the discussion the presentation is used. Presentations are made by students and the teacher acts as a facilitator. The teacher can test students' abilities to describe science process skills through question and answer sessions. Question and answer sessions between students and teachers, helping to improve student interpersonal skills and fine skills. The use of physics comic media can attract students to conduct thermodynamic practicum activities. Mapping of science process skills can be displayed in tables and graphs in Table 2, Table 3, Figure 3, Figure 4, and Figure 5.

The results of the attitude of cooperation during implementation and modelling are not much different. Researchers only have one class so that during modelling and implementation using subjects that are the same as time and different teaching materials. The percentage of observation sheets and questionnaires on cooperative attitudes are categorized as good for all students. So it can be said that the application of this comic media is considered successful.

5. Conclusion

The development learning media of physics comic developed feasible use in learning. Students mapping cooperate attitude when implementing and modelling class in thermodynamic material based on observation sheets and questionnaires were categorized as good for all students

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