Gravity: Jurnal Ilmiah Penelitian dan Pembelajaran Fisika

http://jurnal.untirta.ac.id/index.php/Gravity

ISSN: 244-515x; e-ISSN: 2528-1976
Vol. 6, No. 2, August 2020, Page 102-109

Development of "trainer kit kapasitor" (TRAKTOR) as physics learning media based on science process skills (SPS)

Resty Dwi Asry, Andri Suherman, Asep Saefullah*

Department of Physics Education, Universitas Sultan Ageng Tirtayasa, Indonesia

**E-mail: asaefullah@untirta.ac.id*

(Received: 21 June 2020; Revised: 17 August 2020; Accepted: 20 August 2020)

ABSTRACT

This study aimed to discover how the media feasibility and response of a limited trial of Trainer Kit Kapasitor (TRAKTOR)/ Capacitor trainer kit based on Science Process Skills (SPS) as a physics learning media. The method used was research and development (R&D) with the 4-D model. As a physics learning media, TRAKTOR was designed to facilitate some experiment activities, including a experiment in capacitance parallel plate capacitor, circuits of capacitors (series, parallel, series-parallel) charging-emptying capacitor. The results showed that the media is feasible to use, namely, 93.74%, which was categorized as very feasible, and the media obtained students' responses with an excellent category of 85.2%. Based on the result, TRAKTOR can facilitate students' SPS and media suitable for use as a physics learning media.

Keywords: Capacitor trainer kit, learning media, science process skills

DOI: 10.30870/gravity.v6i2.8383

INTRODUCTION

Physics is a part of science that is useful for finding regularity in the perspective of human observation in the natural surroundings. Learning physics at school aims to make students understand physics concepts in life (Bhakti, 2014). Besides, physics also seeks to prepare students to have a scientific attitude in discovering physics concepts through scientific methods. The scientific method is an activity that is based on scientific characteristics, namely rational, empirical, and systematic (Sugiyono, 2017). The scientific method can obtain through experiment activities. Experiment is a learning method that aims to form concepts and explain physical phenomena. The purpose of physics is developing experiences to formulate problems, make a hypothesis and test it through experiments, design and assemble experimental instruments, collect, process and interpret data, and communicate experimental results verbally and in writing (Hodosyová, Útla, Vnuková, & Lapitková, 2015).

The results of interviews with ten random students in one of the High Schools (SMA) in the Pandeglang city, that experiment activities are more fun than learning theory in class. However, in reality, there are still a few experiment activities carried out; one of the causes is the limited equipment to support experiment activities. While the experiment equipment is essential because it can illustrate physical phenomena along with abstract concepts, optimizing the linkages of all elements of learning and the involvement of all the senses of students so that students more readily understand conceptual material, in this case, is capacitor material (Cahyono, Prabowo, & Setyo, 2018). In his book, Arsyad (2017) states that learning media is experiment equipment that can concretize abstract things so that they can be reached with a simple thought and can be seen and felt.

The 2013 revised curriculum stated Basic Competencies/ Kompetensi Dasar (KD) 4.2 for class XII, which requires experiment activities that contain experiment activities on the capacitor material (charging and emptying capacitors). Therefore, it is essential to conduct experiments related to capacitors to support the physics learning process. One of the skills honed in experiment activities is the science process skills (SPS). Following research has been done that physics experiment can influence and improve science process skills (Wiwin & Kustijono, 2017). Another study also states that learning science, especially physics, is inseparable from the development of science process skills (Siswanto, Yusiran, & Fajarudin, 2016).

The equipment in the school laboratory is considered to be sufficient and complete enough. However, in this study, the researcher wants to examine more closely related to capacitor experiment. The capacitor experiment activity has not been carried out due to the unavailability of parallel plate capacitor equipment, but the capacitor circuit and charging-emptying are available in separate components. So, the capacitance material of pieces of capacitors is paralleled only through the learning process in the classroom. The interview result with a physics teacher at one of the high schools in Pandeglang also stated that the students' skills at the experiment time considered to be lacking.

As research has been done by Muhaimin & Soeprianto (2015), which states that the real concept picture is displayed by learning media in the form of capacitor media helps students to be able to present predictions of phenomena that will occur related to the problems presented. The real concept picture shown by capacitor media influences students' ability to combine with other knowledge to form new knowledge experience relevant to the given question. Other research states that students' SPS increases because, during the experiment, students challenged to observe and solve problems (Malik, Handayani, & Nuraini, 2015).

The development of previous research conducted by Muhaimin (2015) is by modifying the experiment equipment. The advantage of TRAKTOR is easy to carry everywhere (portable). This study has some similarities with previous research; namely, the media is used to facilitate some experiment activities, such as parallel capacitor capacitance, charging and emptying of the capacitor, and capacitor circuits. This study is different from previous research that previous research is focused on scientific attitudes and understanding of student concepts while this study is focused on students' SPS. Also, the development of this study is that the media is accompanied by a capacitor experiment guide based on SPS and not a cookbook. Based on the problems and previous research that have been carried out, the study will be conducted with the title "Development of Capacitor Kit Trainer (TRAKTOR) as a Physics Learning Media Based on Science Process Skills (SPS)".

RESEARCH METHODS

The method used is research and development (Research and Development). The steps of research and development of experiment equipment in this study use the 4-D model developed by Thiagarajan (1974). The 4-D development model consists of four main phases; there are define, design, develop, and disseminate. At the defining aspect, the analysis is carried out by the study literature, observation, and interviews. The defining phase is carried out by identifying the problem, the students' characteristics, the concepts to be taught, and the formulation of learning objectives. At the design phase, choosing the appropriate lesson topic, selecting a format, and designing the design of the experiment equipment developed. The next phase of development is the making of TRAKTOR. Then, validation was carried out by three validators. After going through revisions based on input from expert validators, a randomized trial was conducted on five high school/ vocational students randomly in Pandeglang to determine the feasibility of the development product. The trial results are used to improve the product. After being repaired, the product is tested again until it reaches a useful media and approaching theory. Next is the distribution phase, where the media are distributed to get responses, feedback to the TRAKTOR that has been developed.

Data analysis

Data analysis techniques used in this study are qualitative analysis techniques and quantitative analysis, can be described as follows:

1. Qualitative analysis

Qualitative analysis is used to describe the results of expert validators' suggestions, user responses, documentation, and observation notes when implemented. The data were analyzed qualitatively; some ideas will be used to improve the product at the revision phase, while the documentation notes are described to determine the usefulness of the product developed when used in learning.

2. Quantitative analysis

Quantitative analysis is used to describe the quality of experiment kits based on expert validators' assessments and students' responses after using capacitor experiment kits based on science process skills. Measuring TRAKTOR's feasibility as a developed learning media, expert validation questionnaires, and students' responses used a Likert scale with five alternative answers. For each question given that is very good (VG), good (G), quite (Q), less (L), and very lacking (VL). The qualitative assessment was changed to quantitative with the following score rules

Tabel 1. Giving Expert Test Questionnaire Scores

Category	Score
Very good	5
Good	4
Quite	3
Less	2
Very lacking	1

The value obtained from each aspect is then percentage by the following formula:

$$NP = \frac{R}{SM} \times 100\% \quad (1)$$

Information: "NP" is percentage value, "R" is total score obtained; and "SM" is maximum score.

The percentage value obtained is then converted to a qualitative value with the criteria in table 2.

Tabel 2. Ideal Assessment Categories for Expert Test

Score(%)	Qualitative category
81-100	Very feasible
61-80	Feasible
41-60	Quite feasible
21-40	Less feasible
0-20	Not feasible

The experimental results were then compared with the results of research conducted by Rusmiati (2013) namely the acrylic dielectric constant value of 3.04 ± 0.33 using the equation (Astuti, 2016):

$$\varepsilon = \left| \frac{X_{experiment} - X_{theory}}{X_{theory}} \right| \times 100\% \quad (2)$$

Where, is error percentage (%); is $X_{experiment}$ experi- ε ment result; X_{theory} and is theory result.

RESULT AND DISCUSSION

The first phase (define) produces the conclusion that one of the experiment equipment needed is an experiment capacitor. Then proceed to the second phase, namely design. This phase creates the design of the capacitor kit trainer that will make, as shown in Figure 1. At the development phase (develop), we carried out the process of making media that refers to the design that has made. Figure 2 shows the TRAKTOR media that have been made. The media is equipped with a storage box and is portable (can be carried anywhere) with dimensions of 46 x 30 x 14 cm. The media consists of components and materials that make up the equipment's proportional design so that it makes users interested in using it. The media is also equipped with experiment guides so that it is easy to use (user friendly). The following are some of the results of experiments that have been conducted using a capacitor kit trainer that has been made.

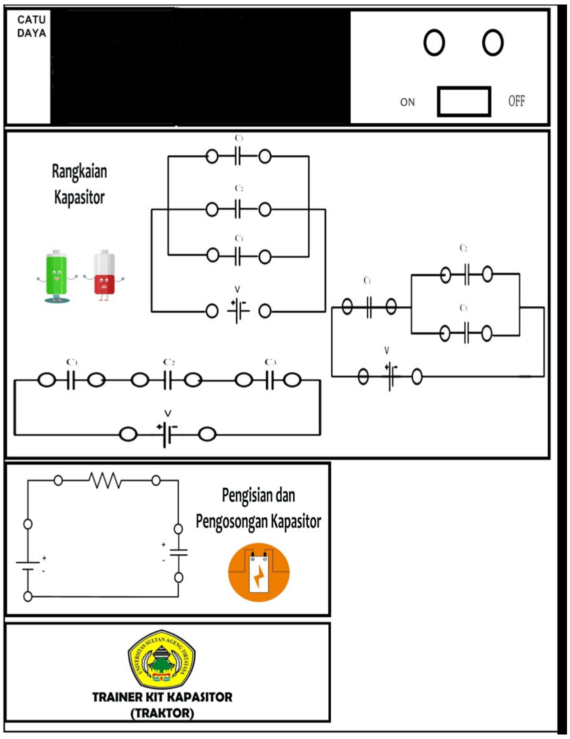

Figure 1. Top view of the design of the capacitor kit trainer (TRAKTOR)

Figure 2. Full TRAKTOR

Parallel plate capacitor experiment

In the parallel plate capacitor experiment, a trial carried out using dielectric media in the form of acrylic. The results of the experiment can be seen in table 3.

Table 3. Result of parallel plate capacitor experiment

Dielectric	Dielectric thickness	Error
Air	0,5 cm	2,00%
Acrylic	0,6 cm	7,89%
Acrylic	0,7 cm	4,60%
Acrylic	0,9 cm	3,61%

The calculation results show that the error that occurred is still below 10%, meaning that TRAKTOR can be used for physics experiment activities on the capacitor material. An error can occur due to air trapped between the dielectric and the capacitor plate. The air dielectric constant and the acrylic constant are different, so the dielectric circuit in the capacitor plate will be different, whether forming a series or parallel between acrylic and air. Therefore, there is the air that is trapped influences and causes the resulting capacitance to differ from the theoretical calculation results. Also, mistakes can be caused by the imperfect (less symmetrical) shape of the chip.

Capacitor circuit experiment

In the capacitor circuit experiment, two types of experiments are carried out: series and parallel circuits. In both experiments, a trial was carried out on the charge stored on the capacitor. In the series circuit the charge results obtained on each capacitor, data collected as follows: Q_1= 1101,68μC, Q_2= 1096,98μC, Q_3= 1106,00μC, and Q_{tot}= 1121,12μC. The difference in charge stored on each capacitor against the total charge can be seen in table 4.

In theory, the capacitors are arranged in series. $Q_1 = Q_2 = Q_3 = Q_{tot}$. The difference in laboratory experiments results with theory still under the tolerance, the average of the differences below 5%. It shows that the trainer kit works quite well in the experiment series capacitor circuit. The difference results are caused by several factors, including the accuracy of measuring instruments—the conditions of the constituent components of equipment, and the obstacles in the cable connecting each component.

Table 4. The charge stored in the series capacitor

Capacitor	Electrical charge (μC)	difference
Capacitor 1	1101,68	1,73%
Capacitor 2	1096,98	2,15%
Capacitor 3	1106,00	1,35%
Series circuit	1121,12	0,00%

As for the parallel capacitor circuit experiments, data obtained as follows: Q_1 = 2758,9μC, Q_2 = 2758,9μC, Q_3 = 5870,0μC, and Q_{tot} = 11378,8μC. The results of this experiment are one hundred percent (100%) according to the parallel capacitor circuit theory, where the total charge is equal to the total charge on each capacitor, $Q_{tot} = Q_1 + Q_2 + Q_3$.

Charging and emptying capacitor experiment

The capacitor kit works well in the capacitor charging and emptying experiments. Figures 3 and 4 show the graph of charging and emptying capacitors of the experimental results.

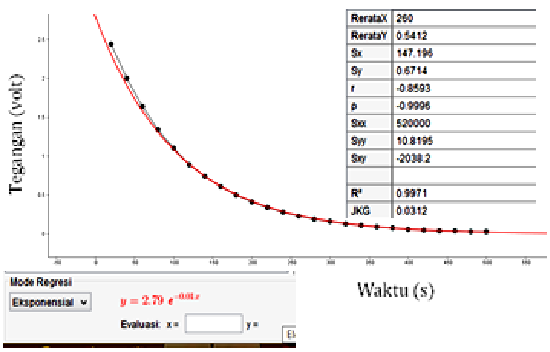

Figure 3. Capacitor emptying

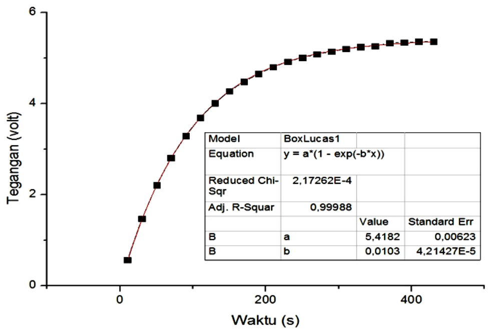

Figure 4. Capacitor charging

The results obtained in the capacitor charging and emptying experiments in figures 3 and 4 show the concordance between the experimental results and the theory, which is an exponential graphical form. The design of TRAKTOR media based on SPS on the capacitor material that has been validated by the validators has several changes and then revised based on the suggestion of the validator, among others, adding the total mass information of the TRAKTOR as a whole. Before being reviewed, TRAKTOR developed assessed by the validator. SPS indicators were adapted from Ongowo & Indoshi's (2013) research and Widian Pangestika, Suryanto, & Viyanti (2013). The indicators including observing, classifying (classifying), predicting (predicting), communicating, interpreting observations (interpreting), control variables, hypothesize, plan experiments/ investigations, and apply sub-concepts/ principles. Based on the results of the TRAKTOR media assessment by the validator obtained an average yield of 93.74% with a very feasible category. Then, the product is limited to testing the user response to high school students as many as five people randomly. The results of the trial response get a percentage of 85.2% with the category of Very Good.

Figure 5 is the result of the acquisition of TRAKTOR media assessment by 2 validators consisting of several aspects, then the results of each aspect are averaged to obtain a final percentage of 93.74% with a very feasible category.

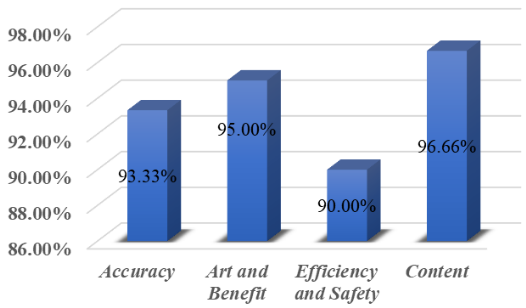

Figure 5. TRAKTOR validation result

The validation results on the aspects of efficiency and safety have a percentage with the smallest value, among other aspects, due to deficiencies in the TRAKTOR media. Which is that this media can generate stun when used if the safety during the trial is not used, meaning in the use of this media must pay attention to the safety and conditions or place of the experiment. For example, when using media is not recommended in a place where the user's body touches directly with the surface of the earth, except using an insulator that prevents members of the body from the surface of the earth such as the use of rubber-based footwear (Herminiwati, Yuniari, Sugihartono, & Sholeh, 2015). Then for the aspect of accuracy has the second smallest value after security because TRAKTOR media do not have perfect equipment accuracy, but there are errors from the data generated. Besides, the efficiency in the instructions for using the equipment is based on the validator's suggestion that using the power supply must be made more explicit by providing pictures and symbols to be more easily understood by the user and safe (preventing damage to the equipment). The validator also added that the layout of the buttons was not right, and there was no switch indicator on the power supply, but due to the researcher's limitations, suggestions could not be made. Aspects of interests and interests and material aspects have the highest percentage because TRAKTOR media are designed to attract

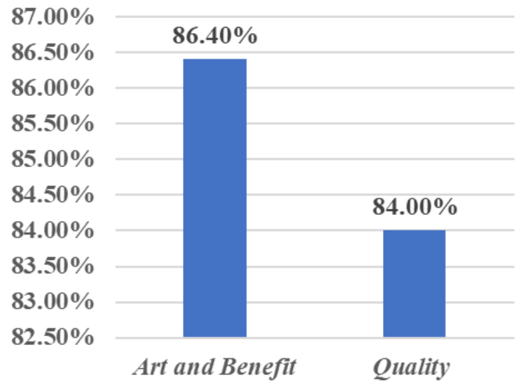

Figure 6. The limited trial result

Figure 6 is the result of the acquisition of a limited response trial by five high school / vocational equivalent students randomly consisting of several aspects, including aspects of attractiveness and benefits (aspects of art and benefit) and aspects of media quality (quality). Then the results of each aspect are leveled - Flattened to obtain a final percentage of 85.2% with a perfect category. But there are some obstacles in the implementation of the limited response trials. Namely, the initial understanding of students about experiment equipment still lacks because students rarely do experiment activities, and students have never done experiment activities on electrical material. Therefore, students are first given an understanding of the use of media, such as measuring instruments and introducing experiment components. In experiment guides, there are ways of using equipment and introducing media; only students feel insecure and afraid of making mistakes because they are not accustomed to using equipment and components.

The results of the validation by the experts and the students' responses presented previously show that TRAKTOR based on SPS is appropriate and get good answers from users. Based on the data that has been obtained and analyzed, it can be synthesized that TRAKTOR media is said to be feasible to use with some notes of advantages and disadvantages. Here are some advantages and disadvantages of the capacitor kit trainer that has been made.

TRAKTOR can facilitate some experiments, including dielectric material in the capacitor, circuits of capacitors (series, parallel and mixed), charging and emptying capacitor. Besides that, TRAKTOR is packaged in an attractive form and easy to carry everywhere (portable). Also, TRAKTOR used in experiment activities are already equipped with components that support experiment activities and are equipped with experiment guides.

The researcher's limitation in arranging a circuit on the power supply cause electricity to propagate if the user's body is attached directly to the ground. Also, the equipment storage box has no handle to make it easier to move the equipment. These TRAKTOR media are made of corrosive components. That is, maintenance of TRAKTOR media must be done routinely and well.

After finishing the final product and limited testing, which is then revised according to the validators' suggestions, the next step is the disseminate phase. The dissemination phase of this study was limited. It gave TRAKTOR to the Laboratory of Physics of Universitas Sultan Ageng Tirtayasa so that it could be used to facilitate experiment activities on the capacitor material and be used as well as possible. Due to the limitations of research in terms of time, funding, and researcher's ability, the TRAKTOR media not carried out dissemination on a large scale, meaning that it is not produced in large quantities.

The results obtained in this study are in line with Muhaimin (2015) research that the resulting capacitor media can be used for experiment activities and get good results. Muhaimin's (2015) research focused on scientific attitudes and understanding of student concepts while in this study focused on students' SPS. Another difference is by modifying the shape of the media into a portable kit trainer. The media is accompanied by a capacitor experiment guide based on SPS, where the manual is not a cookbook. This study is also relevant to research conducted by Cahyono et al. (2018), where experiment equipment in experimental-based learning can illustrate physical phenomena and abstract concepts, optimizing the linkages of all elements of education and the involvement of all learners' senses. It means that experiment equipment can support student skills involving all the senses, namely science process skills, in this case, on the capacitor material.

CONCLUSION

Capacitor Experiment Kit Trainer based on SPS has been produced very well and can be used for the learning process, especially capacitor experiment activities, to facilitate students' science process skills. This media was declared feasible with a value of 93.74% with a very feasible category, as well as getting students' responses in the very good category of 85.2%.

REFERENCES

Arsyad, A. (2017). *Media Pembelajaran*. jakarta: Rajawali Pers.

Astuti, I. A. D. (2016). Pengembangan alat eksperimen cepat rambat bunyi dalam medium udara dengan menggunakan metode Time of Flight (TOF) dan berbantuan software audacity. *UPEJ Unnes Physics Education Journal*, *5*(3), 18–24.

Bhakti, A. S. (2014). *Pengembangan model pennilaian autentik berbasis kurikulum 2013*. Universitas Negeri Malang.

Cahyono, A., Prabowo, & Setyo. (2018). Pengembangan Alat Praktikum Gaya Lorentz Sebagai Media Pembelajaran Fisika. *Jurnal Pendidikan Fisika*, *07*(02), 180–184.

Herminiwati, S., Yuniari, A., Sugihartono, & Sholeh, M. (2015). Pembuatan Karet Ebonit Pada Berbagai Variasi Karet Alam, Karet Riklim, Dan Sulfur Untuk Isolator Panas. *Teknologi Agro-Industri*, *2* (1).

Hodosyová, M., Útla, J., Vnuková, P., & Lapitková, V. (2015). The Development of Science Process Skills in Physics Education. *Procedia - Social and Behavioral Sciences*, *186*, 982–989. https://doi.org/10.1016/j.sbspro.2015.04.184

Malik, A., Handayani, W., & Nuraini, R. (2015). Model Praktikum Problem Solving Laboratory untuk Meningkatkan Keterampilan Proses Sains Mahasiswa. *Prosiding Simposium Nasional Inovasi Dan Pembelajaran Sains*, 194. Retrieved from https://faridach.files.wordpress.com/2017/10/neng-tresna-more.pdf

Muhaimin, A., & Soeprianto, H. (2015). Development of Capacitor Media and Effect on Students ' Understanding of Concept and Scientific Attitude. *Jurnal Pendidikan Fisika Indonesia*, *11*(1), 59–72. https://doi.org/10.15294/jpfi.v11i1.4004

Ongowo, R. O., & Indoshi, F. C. (2013). Science Process Skills in the Kenya Certificate of Secondary Education Biology Science Process Skills in the Kenya Certificate of Secondary Education Biology Experiment Examinations. *Creative Education*, *4*(January 2013), 713–717. https://doi.org/10.4236/ce.2013.411101

Rusmiati, Y. (2013). Eksperimen Penentuan Konstanta Dielektrik Akrilik Dengan Menggunakan Prinsip Kerja Capacitor Plat Sejajar.

Siswanto, Yusiran, & Fajarudin, M. F. (2016). Keterampilan Proses Sains Dan Kemandirian Belajar Siswa : Profil Dan Setting Pembelajaran Untuk Melatihkannya. *Gravity*, *2*(2), 190–202.

Sugiyono. (2017). *Metode Penelitian kuantitatif, kualitatif, dan R&D* (26th ed.). Bandung: Alfabeta.

Thiagarajan, S. (1974). *Instructional development for training teachers of exceptional children*: A sourcebook.

Widian Pangestika, M., Suryanto, E., & Viyanti. (2013). Pengembangan Lembar Kerja Siswa Berasis Keterampilan Proses Sains pada Kompetensi Dasar Menyelidiki SIfat-Sifat Zat Berdasarkan Wujudnya dan Penerepannya dalam Kehidupan Sehari-Hari. *Jurnal Pembelajaran Fisika*, 55–65.

Wiwin, E., & Kustijono, R. (2017). The use of physics experiment to train science process skills and its effect on scientific attitude of vocational high school students. *Seminar Nasional Fisika*, 0–8. https://doi.org/10.1088/1742-6596/997/1/012040