ISSN (PRINT) : 2549-9955 ISSN (ONLINE): 2549-9963
JURNAL ILMIAH PENDIDIKAN FISIKA
https://ppjp.ulm.ac.id/journals/index.php/jipf/index

Is 21st Century Learning Need STEM Approach built into Physics Comics?

Maria Fatima Nareswari Mardi Utami*, Mastuang, and Surya Haryandi
Universitas Lambung Mangkurat, Banjarmasin, Indonesia
*nares.utami12@gmail.com

Abstract

This study aims to analyze the effectiveness of using comic teaching materials in physics learning, focusing on the topic of effort and energy. The background of this research is based on the need to improve the quality of physics learning and improve student learning outcomes. In Indonesia's education context, efforts continue to be made to improve STEM-based education (Science, Technology, Engineering, Mathematics) to keep up with the development of the 21st century. In the context of this research, comic teaching materials are used as a new alternative to overcome problems in physics learning. This research was conducted in one of the public high schools in Banjarmasin and used the ADDIE development model (Analysis, Design, Development, Implementation, Evaluation). Data were collected through student learning outcomes tests before and after using comic teaching materials. The results showed that this comic teaching material significantly increased student learning outcomes. Student scores increased from a low of 0.00 to 43.00 and a high of 18.50 to 80.50. This increase in learning outcomes test is included in the medium category. This research contributes to developing comic teaching materials as an effective and innovative learning media in physics learning. It is expected that the results of this study can be a reference for educators and curriculum developers in improving the quality of physics learning in Indonesia. In addition, this research also encourages further development and utilization of creative media in education to increase student motivation and interest in learning.

Keywords: Comics; Learning Results; STEM; Teaching Materials

Received : 7 November 2022
Accepted : 31 July 2023
Published : 28 August 2023
DOI : https://doi.org/10.20527/jipf.v7i2.6780

How to cite: Utami, M. F. N. M., Mastuang, & Haryandi, S. (2023). Is 21st century learning need STEM approach built into physics comics?. *Jurnal Ilmiah Pendidikan Fisika*, *7*(2), 319-327.

INTRODUCTION

Education is a component related to the quality of human resources. Learning is a system in which all elements interact with each other. Many factors influence learning activities. Learning in science is a comprehensive modification of the subject matter's content for students. The success of the learning process can be seen by carrying out evaluations (Putri et al., 2021; Rahmawati & Harta, 2014).

Indonesian education is always expected to increase every year. STEM learning has been used in America, and Indonesia is also expected to improve its education by using STEM-based learning

(Artobatama, 2018; Hartini et al., 2020). Education is also one of the long-term investments that must be continuously optimized to achieve a determining factor for a better life in a nation. This optimal education can be realized in various ways, including by improving the curriculum used, conducting training for educators, and developing and innovating teaching materials that will be used as learning resources for students (Hamka & Arsyad, 2015). The learning process is an activity between teachers and students to realize a learning goal. Teachers are required to guide students to grow and develop physically, psychologically, attitudes, and other skills (Wahid, 2018).

Learning carried out using a *STEM* approach is the right learning to be used: it is suitable and appropriate to use along with the development of the 21st century (Eguchi, 2016; Perdana et al., 2021). *STEM* also integrates science, technology, engineering, and mathematics in a learning curve. The emphasis on STEM learning is accompanied by active learning, combining the four components and focusing on *STEM* information in everyday life. Taking a *STEM* approach, discussing natural science and relating it to technology, engineering, and mathematics. Learning physics with a STEM approach consists of 1) Aspects of science, which contain knowledge and skills of the science process to understand and manipulate the symptoms of nature; 2) Technological aspects, by knowing how new technologies can be developed and technologies can be used to facilitate human work; 3) Engineering aspects, by operating and designing or assembling and referring to science and technology; 4) Aspects of mathematics, by analyzing and conducting a proof and solving problems in the calculation results (Siswanto, 2018).

Students depend on educators, and this can be handled by giving teaching materials to students so that students can learn for themselves about the material that will be provided by education in the future. According to the explanation from Prastowo (2013), teaching materials are all materials consisting of information, tools, and texts that are systematically compiled to produce a complete result of competencies that students then master. It then will be applied to the learning process and aimed to plan and study the implementation of learning.

Teaching material is a learning material tool that will explain learning objectives, provide exercises, anticipate learning difficulties in students, and help provide learning motivation. In its preparation, it will be loaded based on the material's core competencies and basic competencies. Teaching materials greatly influence the building of effective and efficient learning activities (Wati et al., 2021). Teaching materials can be in the form of human or non-human resources. They can also become alive and dead. Educators or learners can easily purchase and create Teaching and learning materials.

According to Purnomo & Indrowati (2013) in (Sari *et al*., 2019), learning resources are necessary means, separately and in combination. Thus, learning resources are expected to support the learning process, which can be in the form of textbooks, magazines, or print media, as well as in the current era where the majority use a lot of electronic media, resource persons, the surrounding environment, and so on. Using these learning resources can make it easier for students to achieve learning goals or competencies. Learning materials are crucial things in learning activities.

In compiling a lesson, we need to plan and design what material should be learned to achieve competency, so it is necessary to develop learning material. Teaching material is a message that will be delivered in the form of facts, ideas,

concepts, and so on, packaged in sentences, writing pictures, maps, or signs (Julian, 2012).

Teaching materials have many types consisting of printed and non-printed teaching materials, which in this study used non-printed teaching materials. This physics comic teaching material can provide entertainment and an understanding of physics concepts in everyday life. Comics can be a fun source of learning while learning physics. Comics can be interpreted as a form of cartoon depicted through a character by applying it to a storyline that is closely related to images that are processed in such a way as to provide entertainment to the readers (Daryanto, 2011) in (Ntobuo et al., 2018; Wurwiarwin et al., 2018).

Comics can be used as innovations from teaching materials to overcome problems in a learning activity. It helps to understand a material that has a simple, clear, and easy-to-understand nature. Students tend to be interested in reading books such as comics, which have lots of pictures and interesting storylines and coherent storylines so that they can make it easier for students to remember. Children prefer illustrated stories or reading books that contain interesting and entertaining pictures, such as comics. Comics can be used as a form of teaching material that can be used to overcome problems in understanding a material that has simple, clear, easy-to-understand characteristics (Lesmono *et al*., 2012; Nurdin et al., 2020; Sari, 2021). Comics can be a fun source of learning when learning physics (Pratiwi, 2016). This physics comic teaching material can provide entertainment and understanding of physics concepts in everyday life. The comic teaching material contained in this research is the development of unique visual communication media by collaborating creatively packaged text and images. It has the advantage that this teaching material is expected to convey information in the form of business and energy learning materials. It can be accessed with an Android and iOS internet connection (Soemantri, 2019).

This research focuses on developing unique and different visual communication media by collaborating creatively packaged text and images and has the advantage of being able to convey information in the form of material in a new and fun way. Many of America's most famous animated films, especially those from Warner Bros and Metro-Goldwyn-Mayer studios, have indirectly developed a relatively consistent set of "laws" necessary for comic animation. They usually involve things that behave according to the appearance of the cartoon character or what the character expects rather than how objective they are.

In one common instance, gravity has no effect when a cartoon character runs off a cliff until the character notices it. This teaching material contains class X “work and energy” materials for three meetings. This teaching material also contains *STEM* information that is appropriate and still related to the topic of business and energy material.

In *STEM-based* education, students will be encouraged to reason and think critically, systematically, and logically so that students will later be able to face global challenges. *STEM* focuses on the ability of an individual to apply an understanding of how difficult and fierce competition is in the world, especially in the 21st-century era. Active learning usually accompanies STEM (Kressler & Kressler, 2020; Nessa *et al.*, 2017; Uskoković, 2017).

The novelty of this comic teaching material can provide a new atmosphere, and it is hoped that students will enjoy more and not be bored in physics learning activities, especially on the topic of work and energy. The following is a comparison of this research comic and previous research; from the appearance, Lesmono comics used storyline columns,

while this study did not use storyline columns because it was intended to make it easier for students to understand the storyline of the material presented.

The characters displayed are made as if they are students trying to apply effort and energy to daily activities.

METHOD

The method applied to this research is a research and development method. The product developed in this study is a physics comic teaching material containing *STEM* on grade X's work and energy materials. Effectiveness in terms of student learning outcomes tests, in the form of pretest and posttest in the cognitive domain, to determine the level of achievement of student learning outcomes tests that have used physics comic teaching material. Effectiveness is reviewed from student learning outcomes tests, in the form of pretests and posttests in the cognitive domain, to determine the level of achievement of student learning outcomes tests that have used physics comic teaching materials. Where the student learning outcomes test has been validated and adjusted with input from expert validators, and each question corresponds to the subject matter of energy effort with cognitive domains from C2 to C5. Effectiveness can be calculated using the normalized gain (N-gain) formula. The research design used follows the ADDIE stage. This model is suitable for applying to a curriculum that focuses on knowledge, skills, and attitudes (Cheung, 2016) in (Noviyanti & Gamaputra, 2020). Here is an image in Figure 1 of the ADDIE development model chart.

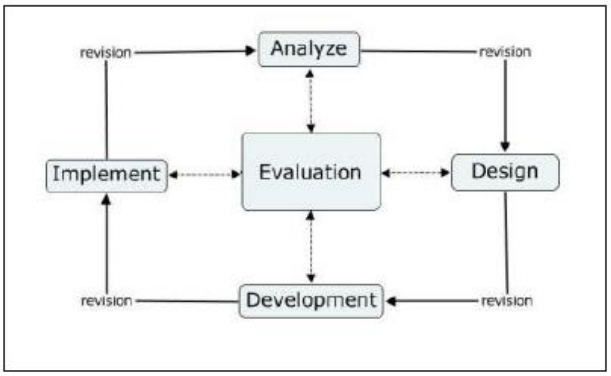

Figure 1 ADDIE development model

This teaching material was created and developed using the *Canva* application, which is then processed into an electronic book using professional PDF flip software. This software is easy to use and adapts to the device's screen size. Teaching materials that have been developed are validated by 3 expert validators consisting of 2 academic validators who are physics education lecturers and one practitioner validator who is a physics subject teacher in one of Banjarmasin's high schools. Teaching materials that have been tested for validity were then tested on 18 students in one of the state high schools in Banjarmasin.

The field trial in this study was carried out on 18 students of one of the high schools in Banjarmasin City from May 13, 2022, to May 21, 2022. The research was conducted face-to-face following the learning process in schools that have established face-to-face learning activities. The following is a presentation of data results obtained during the trial in class, judging from the results of the practicality and effectiveness of STEM-based physics comic teaching materials.

The trial was carried out by conducting three learning meetings for 2JP × 45 minutes. In the first meeting, students were given a pretest and then learning using physics comic teaching materials. Students learned using physics comic teaching materials at the three meetings and were given worksheets at each meeting. In the last meeting, students were given a learning outcomes test to determine whether the physics comic teaching material was effective in the learning process (Darmalaksana *et* al., 2020).

The data obtained was then analyzed, and the results were used as feedback on the learning process. In teaching, an educator always expects learners to learn but rarely gives lesson direction on how learners learn (Ndiung & Jediut, 2020).

Effectiveness is reviewed from the student learning outcomes test in the cognitive realm, *pretests*, and *posttests* to determine the level of achievement of the learning outcomes for students who have used physics comic teaching materials. The effectivity is then calculated using the normalized gain *formula (N-gain.* The following table shows the results:

Table 1 N-Gain Score

Description	***Pretest* score**	***Posttest* score**
Lowest score	0.00	43.00
Highest score	43.00	80.50
Mean	6.42	65.36
Pass	0 (0%)	61.1%
N-gain score	0.63	
Category	Moderate	

RESULTS AND DISCUSSION

The purpose of this research is to know and also to analyze the effectiveness of teaching materials in the form of comics. The background of this study is to find out how the use of comics in physics learning can increase student scores. This study used the ADDIE development model. The trial in this study was carried out at one of the state high schools in Banjarmasin. Data collection techniques were carried out using learning outcomes tests for students. The results of this study show the feasibility of the results of teaching materials and the effectiveness in terms of learning outcomes to students where the lowest score of the previous student was 0.00 to 43.00, and the highest score of the previous student was 18.50 to 80.50, where the increase in the learning outcomes test was included in the moderate category.

This research developed *STEM-charged* physics comic teaching materials on work and energy topics, which was carried out at one of the high schools in Banjarmasin. Academic experts and practitioners validate teaching materials, test them in class, and then simulate and test them to produce valid, practical, and effective learning tools. Teaching materials greatly influence the building and support the creation of effective and efficient learning activities (Wati et al., 2021). Teaching materials are called feasible if they meet the minimum categories of valid, practical, and effective.

The effectiveness of the teaching material developed can be reviewed from the learning outcomes for students contained in Table 1, where the lowest score of the previous student was 0.00 to 43.00, and the highest score of the previous student was 18.50 to 80.50. The Minimum Completion Criteria (MCC) determined by the school for physics lessons is 70, so the number of students before the implementation of the teaching material developed is 0 people (0%) to 11 people (61.1%). Based on the description and Table 1 above, the teaching materials developed are effective in learning activities and student learning outcomes.

Based on research conducted by Guntur et al. (2017), The application of teaching materials in the mathematics course's learning process is needed by an educator. One of the teaching materials that an educator can use to foster an independent learning attitude in students

is comic teaching materials. Comic teaching material can also be one of the communicative media for learning. This article describes the analysis of popular learning theory using the study of relevant literature, in the concept that learning theory is an integral part of the teaching and learning process used to realize learning for learners. In this article, four popular learning theories were analyzed, namely: intelligent character education, quantum learning, acceleration learning, active learning, and hypno teaching.

The theory of learning, according to Jean Piaget (Ismail & Mudjiran, 2019), also supports that at the formal operational stage (over 12 years old), students have been able to build their knowledge structure by freeing students to build their knowledge on the learning model used by educators, so that this learning theory supports the development of physics comic teaching materials developed.

Figure 2 Content of physics comic teaching materials
https://online.fliphtml5.com/taghj/iwhe/?1652291624062

Applying STEM-based physics comic teaching materials in the learning activities can improve learning outcomes in students (Table 1). The increase in value is because students have understood how to solve problems with the media of physics comic teaching materials provided. This is in line with several studies that state that the use of comic media in STEM learning is feasible and can improve student literacy (Aprilia et al., 2023; Handayani, 2021; Suryani et al., 2023; Winarni & Koto, 2021).

CONCLUSION

The development of STEM-based physics comic teaching materials has concluded that *STEM*-charged teaching materials on business and energy materials are considered feasible to improve student learning outcomes in physics learning, based on the learning outcomes of students getting a moderate category. Thus, the development of this physics comic teaching material is declared effective to be applied to learning. Based on the development of STEM-based physics comics teaching materials that have been carried out, it is known that STEM-charged teaching materials on effort and energy materials are considered feasible to improve student learning outcomes in physics learning; this is based on student learning outcomes that get a moderate category. So that the development of this physics comic teaching material is declared effective to be applied to learning. The suggestion for this research to be even

better is to apply other learning methods besides direct instruction and cooperative learning to STEM-loaded physics comic teaching materials and then compare the results of existing research and what was done and then perfect the shortcomings of the research found. In addition, researchers can also monitor students' reactions to physics comics in the material of effort and energy so that it can be seen how far students' understanding and interest in physics learning are combined with STEM-loaded comics.

REFERENCES

Aprilia, G. M., Nabila, H., Karomah, R. M., HS, E. I., Permadani, S. N., & Nursyahidah, F. (2023). Development of probability learning media PjBL-STEM based using e-comic to improve students' literacy numeracy skills. *Kreano, Jurnal Matematika Kreatif-Inovatif, 14*(1), 160-173.

Artobatama, I. (2018). Pembelajaran stem berbasis outbound permainan tradisional. *Indonesian Journal of Primary Education*, *2*(2), 40-47.

Azizul, A., Riski, W. Y., Fitriyani, D. I., & Sari, I. N. (2020). Pengembangan bahan ajar komik digital pada materi gerak. *VOX EDUKASI: Jurnal Ilmiah Ilmu Pendidikan*, *11*(2), 97–104.

Darmalaksana, W., Hambali, R. Y. A., Masrur, A., & Muhlas. (2020). Analisis pembelajaran online masa WFH pandemic covid- 19 sebagai tantangan pemimpin digital abad 21. *Karya Tulis Ilmiah (KTI) Masa Work From Home (WFH) Covid-19 UIN Sunan Gunung Djati Bandung*, 1–12.

Eguchi, A. (2016). RoboCupJunior for promoting STEM education, 21st century skills, and technological advancement through robotics competition. *Robotics and Autonomous Systems*, *75*, 692-699.

Guntur, M., Muchyidin, A., & Winarso, W. (2017). Pengaruh penggunaan bahan ajar matematika bersuplemen komik terhadap kemandirian belajar siswa. *Eduma : Mathematics Education Learning and Teaching*, *6*(1), 43.

Hamka, H., & Arsyad, M. N. (2015). Keefektifan penerapan model pembelajaran langsung pada materi sistem gerak di SMA Negeri 1 Donri-Donri. *Jurnal Bionature*, *16*(1), 58–64.

Handayani, T. (2021). Pengembangan media komik digital berbasis STEM untuk meningkatkan literasi sains siswa sekolah dasar. *Jurnal Didaktika Pendidikan Dasar*, *5*(3), 737-756.

Hartini, S., Mariani, I., Misbah, M., & Sulaeman, N. F. (2020). Developing of students worksheets through STEM approach to train critical thinking skills. *Journal of Physics: Conference Series*, 1567 (4), 042029. IOP Publishing.

Ismail, R. N., & Mudjiran, N. (2019). Membangun karakter melalui Implementasi Teori Belajar behavioristik pembelajaran matematika berbasis kecakapan abad 21. *Menara Ilmu*, *13*(11).

Julian, S. G. (2012). Pengembangan materi pembelajaran. *Karya Tulis Ilmiah (KTI) Masa Work From Home (WFH) Covid-19 UIN Sunan Gunung Djati Bandung*, *1*(1), 1–12.

Kressler, B., & Kressler, J. (2020). Diverse student perceptions of active learning in a large enrollment STEM course. *Journal of the Scholarship of Teaching and Learning*, *20*(1).

Lesmono, A. D., Wahyuni, S., & Alfiana, R. D. N. (2021). Pengembangan bahan ajar fisika berupa komik pada materi cahaya di SMP. *Jurnal Pembelajaran Fisika*, *1*(1), 100-105.

Ndiung, S., & Jediut, M. (2020). Pengembangan instrumen tes hasil belajar matematika peserta didik sekolah dasar berorientasi pada

berpikir tingkat tinggi. *Premiere Educandum : Jurnal Pendidikan Dasar dan Pembelajaran*, *10*(1), 94.

Nessa, W., Hartono, Y., & Hiltrimartin, C. (2017). Pengembangan buku siswa materi jarak pada ruang dimensi tiga berbasis science, technology, engineering, and mathematics (STEM) problem- based learning di kelas X. *Jurnal Elemen*, *3*(1), 1.

Noviyanti, N., & Gamaputra, G. (2020). Model pengembangan ADDIE dalam penyusunan buku ajar administrasi keuangan negara (Studi Kualitatif di Prodi D-III Administrasi Negara FISH Unesa). *Jurnal Ilmiah Manajemen Publik dan Kebijakan Sosial*, *4*(2), 100.

Ntobuo, N. E., Arbie, A., & Amali, L. N. (2018). The development of gravity comic learning media based on Gorontalo culture. *Jurnal Pendidikan IPA Indonesia*, *7*(2), 246-251.

Nurdin, E., Saputri, I. Y., & Kurniati, A. (2020). Development of comic mathematics learning media based on contextual approaches. *JIPM (Jurnal Ilmiah Pendidikan Matematika)*, *8*(2), 85-97.

Perdana, R., Apriani, A. N., Richardo, R., Rochaendi, E., & Kusuma, C. (2021). Elementary Students' Attitudes towards STEM and 21st-Century Skills. *International Journal of Evaluation and Research in Education*, *10*(3), 1080-1088.

Pratiwi, D. D. (2016). Pembelajaran learning cycle 5E berbantuan geogebra terhadap kemampuan pemahaman konsep matematis. *Al-Jabar : Jurnal Pendidikan Matematika*, *7*(2), 191–202.

Prastowo, A. (2013). Pengembangan Bahan Ajar Tematik Panduan Lengkap Aplikatif. *Yogyakarta: Diva Pres*.

Putri, S. D., Wijayati, N., Mahatmanti, F. W., & Rachmadiyono, D. (2021). Keefektifan materi ajar penyangga berbasis pemecahan masalah pada kemampuan berpikir kreatif siswa. *Jurnal Inovasi Pendidikan Kimia*, *15*(2), 2864–2872.

Rahmawati ES, Y., & Harta, I. (2014). Keefektifan pendekatan open-ended dan Ctl ditinjau dari hasil belajar kognitif dan afektif. *Jurnal Riset Pendidikan Matematika*, *1*(1), 113.

Rambe, M. (2019). Pelaksanaan supervisi akademik sebagai upaya untuk meningkatkan kompetensi guru dalam menyusun rencana pelaksanaan pembelajaran. *Jurnal PAJAR (Pendidikan dan Pengajaran)*, *3*(4), 782-790.

Sari, S. A. (2021). Development of comic-based learning on reaction rate for learning to be more interesting and improving student's learning outcomes. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, *9*(1), 151-167.

Sari, F. A., Suseno, N., & Riswanto, R. (2019). Pengembangan modul fisika online berbasis web pada materi usaha dan energi. *JIPFRI (Jurnal Inovasi Pendidikan Fisika dan Riset Ilmiah)*, *3*(2), 129–135.

Soemantri, S. (2019). Pelatihan membuat media pembelajaran digital. *AKSIOLOGIYA : Jurnal Pengabdian Kepada Masyarakat*, *3*(1), 64.

Suryani, K., Rahmadani, A. F., Khairudin, K., Aziz, A., & Mawaddah, D. (2023). E-Comic pembelajaran pengolahan sampah berorientasi STEM-MEA bagi siswa sekolah menengah. *Edukasi: Jurnal Pendidikan*, *21*(1), 83-97.

Uskoković, V. (2017). Rethinking active learning as a paradigm of our times: towards poeticizing and humanizing natural sciences in the age of STEM. *The Journal of materials education*, *39*(5-6), 241.

Wahid, A. (2018). Pentingnya media pembelajaran dalam meningkatkan prestasi belajar. *Istiqra*, *5*(2), 1–11.

Wati, M., Ridho, M. H., Misbah, M., & Sasmita, F. D. (2021). Pengembangan materi ajar fisika bermuatan authentic learning pada pokok bahasan gerak melingkar. *Jurnal Kependidikan*, *5*(2), 178-193.

Winarni, E. W., & Koto, I. (2021). Pengembangan media komik digital berbasis STEM dalam meningkatkan kemampuan literasi sains siswa. *Jurnal Pembelajaran dan Pengajaran Pendidikan Dasar*, *4*(2), 22-29.

Wurwiarwin, W., Wahyono, U., & Werdiana, I. K. (2018). Pengembangan komik fisika kontesktual berbasis android pokok bahasan tekanan untuk sekolah menengah pertama. *Jurnal Pendidikan Fisika*, *6*(2), 230-243.