Analogy Educational Comics to Overcome Students’ Misconception on Simple Electricity Circuit Material

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1Madrasah Tsanawiyah Negeri 32 Jakarta, Jl. H. Liun, Muhtar Raya, Petukangan Utara, Pesanggrahan, Jakarta Selatan 12260, Indonesia

E-mail: RezaHesti@mtsn32jakarta.sch.id

Abstract. Distance learning during this pandemic makes students more often access the internet for learning purposes. The habit of copying and pasting sources from the internet without confirming the correctness of the information obtained causes misconceptions in students. In the analogy approach, there is a comparison between two concepts that can expand students' thinking patterns. While comics contain explanations of the material outlined in the form of pictorial stories that will attract the attention of the readers. By applying an analogy approach in educational comics that is packaged in the concept of changing conceptions, it is hoped that it will direct analogical reasoning and activate deeper understanding so that it can form scientific conceptions in students. The purpose of this study was to investigate the usefulness of educational comics by analogy in overcoming student misconceptions on simple electrical circuit material. The sample of this study was 30 students at one of the public Islamic junior high school in South Jakarta who were taken purposively. The research method used is a pre-experimental method and the design used is a one-shot case study. Students who were used as samples had identified misconceptions in the electrical circuit material using Simple Electrical Circuit Diagnostic Test (SECDT). The results of this study found that analogy educational comics can replace students’ misconceptions with scientific truths and it was found that 63% were aware of their misconceptions, gained new knowledge and believed in the truth of scientific explanations presented in the comics.

1. Introduction

Many high school students do not like physics lessons. Some material in physics is abstract so it is difficult to study. Coupled with the lack of supporting laboratory equipment, poor teaching methods such as there are still many teachers who teach with the lecture, discussion method, and rely entirely on reading books that focus on memorizing formulas and weak mathematical abilities make students dislike physics even more [1].

Electrical matter is one of the basic materials in physics. Its application covers many aspects of everyday life. Physics concepts in the field of electricity are mostly invisible, and difficult to learn and learn in real terms. The difficulty of students, prospective teachers and physics teachers in understanding a concept can lead to misconceptions. Analogy is believed to be able to influence students’ conceptual understanding of electrical circuit material and help students to correct their misconceptions on this material [2,3].

During this pandemic the internet has become an important means of education. Students use internet facilities in doing school work and dig up various information using search engines such as google, yahoo, and so on. However, students do not have enough skills and knowledge to judge the truth of the
information they get. Anyone can create a website and post information on it without checking its accuracy. Meanwhile students also receive information from the internet without considering sources that are accurate and believed to be true. Students tend to copy and paste without worrying about the reliability of the source. This activity causes mistakes in learning and ultimately leads to misconceptions, so the teacher's participation is needed in directing students to use the internet on the right sites [4,5].

Misconception beliefs are false beliefs in a person's mental model. Misconceptions are also wrong ideas about a concept. Often the misconceptions that are found are strong and difficult to change, so that if the misconceptions are to be changed, they must go through a process of changing the conceptions that involve cognitive conflict and finally the students' cognitive structures change [6]. Experts consider it important that misconceptions that are owned and possessed by students must be removed, because: (1) the conception is different from scientific concepts; (2) it is latent, continues to be used by students and tends to be difficult to change; and (3) difficult to detect by teachers [7]. One of the difficulties students have in understanding electrical circuits ultimately causes misconceptions [8].

There are several methods and strategies used to eliminate misconceptions and promote the process of changing conceptions such as analogies, Conceptual Change Text (CCT), multiple intelligence theory, meaningful learning, constructivist concept maps, semantic analysis tables, network concepts, computer assisted instruction worksheets, and metaphor. The combination of CCT using computer materials such as computer simulations, animations, projection slides, and videos can also facilitate and speed up the process of converting conceptions [9].

Students use the concepts they have in mind to interpret new phenomena, in the process of changing the conception this stage is called assimilation. However, the concepts formed by these students are not sufficient for students to understand other phenomena well, so students have to rearrange the main concepts, in the process of changing the conceptions this stage is called accommodation [10]. Through accommodation, students use pre-knowledge to respond to new phenomena. Accommodation is a process of cognitive conflict that occurs because of differences between students' pre-knowledge and existing scientific explanations. There are several conditions that must be met so that the accommodation stage can be passed by students properly [10], including:

- Dissatisfaction, students must realize the concept they have is inadequate.
- Clarity, new concepts must be understood by students.
- It makes sense, students find new logical concepts and can be imagined in their minds.
- It is fruitful, new ideas are formed and students must be able to solve the same problems with the new concepts they have.

Understanding scientific knowledge from reading a text depends on the reader's pre-knowledge of the concepts being studied. Practical activities in the laboratory, demonstrations, and other activities must be integrated with the text so that students get an understanding of the scientific knowledge that is being studied [11]. This reason makes textbooks and teaching materials in the form of text the dominant source of knowledge. Text-based methods can facilitate the need to overcome misconceptions, so that the development of conceptual knowledge, identifying misconceptions, and designing teaching materials, especially text, is currently needed [12].

Of the several strategies for changing conceptions, text-based analogy has become a quite interesting focus. Text-based analogy is believed to be able to solve problems and be effective in explaining the concept of science. Analogy-based texts are very useful for teachers, of course, by including and emphasizing descriptions of relational elements in them, so they can provide impressive information. Through the process of comparing and discussing the existing differences is one way to improve the potential for misconceptions [13]. From the research results, it was found that analogy instruction can help students to turn misconceptions into scientific conceptions by activating their misconceptions, generating dissatisfaction, and presenting correct, easy to understand and sensible explanations. In analogy, there is an analogy concept with the concept being the target, an explicit relationship is made and the teacher who teaches must know the difficulties of students in understanding scientific conceptions in order to design material to create a meaningful learning atmosphere [3]. Analogy also enhances students' thinking skills such as reasoning skills and critical and creative thinking skills [14].
Therefore the analogy learning model must be adopted by all science teachers, especially physics teachers, in teaching some abstract concepts to students in the class instead of using the conventional lecture method as a measure to improve achievement [15].

Comics are a type of reading that is favored and in demand, not only by children, but teenagers and adults alike really like this type of reading, because in terms of appearance, stories, and the characters of the characters featured in comics are very interesting. There are several types of comics circulating in the market, in the world of education there are also comics which are commonly referred to as educational comics. These comics contain explanations of the material outlined in the form of pictorial stories (comic). Comics can be defined as a form of cartoon that expresses characters and applies a story in order to provide entertainment to the readers [16]. From an educational perspective comics also offer several advantages including facilitating learning [17].

Comics often rely on the use of characters and situation models, which form the basis of emotional attachment and facilitate the formation of new memories [18]. Based on research in the medical field it was found that when compared to traditional text-based material, comics also significantly improved comprehension and memory [19]. Comics are more consistently effective in increasing student engagement and motivation. The results of this study are also in line with the results of other studies, which found that comics were preferred over texts by participants even though the quality of their knowledge did not improve after reading them [20–22].

Comics are read part by part, when getting new knowledge information, the reader can confirm it by re-reading the section. Comics are considered to be an easy and fun format. Complex scientific information can be visualized in comic form [23,24]. Other findings also concluded that the use of comics as a learning medium in Modern Physics courses can make a positive contribution to learning the concepts of Modern Physics [25]. Learning from science comics is also considered to be able to shape understanding and improve memory so that comics become a popular medium and have strong potential to be used in learning [17]. Physics comics provide basic information about physics concepts and give a good impression to motivate student learning [26]. Using simulated cartoon or comic concept worksheets can promote conceptual change in science subjects, can improve conceptual understanding and reverse misconceptions [27,28].

There are many applications that can be applied in making comics, one of which is Comic Life. Based on information obtained on Google Play content, Comic Life is a fun and easy application to make, including for people who cannot draw. By inserting a photo into the panels then making a few edits and selecting the desired design the comic can be used in PDF or photo file formats.

The era of the Industrial Revolution 4.0 which demands a learning system to innovate in an orderly manner and adapt to this digital era. The digital era is closely related to learning media [29]. Teachers must continue to learn to develop technology and information-based learning media so that learning materials can be accessed by students anytime and anywhere. One of the technologies that teachers can take advantage of is developing Microsoft Sway e-learning. Based on the research results, it can also be concluded that project-based student learning outcomes using Microsoft Sway 365 in oxidation reduction reactions are better when compared to project-based student learning outcomes using handouts [30]. Microsoft Sway 365 is an application from Microsoft Office that helps collect data, format data, share ideas, share stories, and can be used as a web-based presentation media [31]. In this media, text, images, documents, videos, graphics, or other animated content can be added [32]. Microsoft Sway 365 as a learning medium can be used by students who are equipped with various animation features [33]. Microsoft Sway can be accessed from various devices when connected to the internet such as via a smartphone, tablet or laptop / computer. Thus, learning can continue without being limited by space and time. Microsoft Sway is also equipped with a group feature that allows us to display two or more images. The final step after developing Microsoft Sway as an online-based teaching material is to distribute the media to students [34].

At the time of this pandemic, a lot of research was carried out related to distance learning but most of it focused on making teaching materials and learning strategies. Not many studies have focused on changing students' conceptions. Even though the possibility of misconceptions in students is very large because their interaction with the internet is becoming more profound nowadays. Students do learning
via the internet, copy and paste activities to sources whose accuracy is unknown in doing assignments cannot be avoided and causes students to experience misconceptions.

In several studies it was found that reading comics was more effective in gaining knowledge when compared to reading text. Reading comics is also more consistent in increasing the involvement of students' motivation in learning. For this reason, the focus of this research is on comics which contain analogous content in order to change students' misconceptions on simple electrical circuit material. Presentation of conception-changing interventions is usually done in the classroom, but in pandemic conditions like this, online presentation with interactive media is needed so that the purpose of changing students' conceptions can occur. The innovative use of Microsoft Sway 365 in presenting analogic comic content that changes conception is considered as a solution to be able to intervene in students' conversion of conceptions into scientific conceptions.

Teaching and learning activities carried out remotely during this pandemic made it difficult for teachers to provide supervision to students. It cannot be avoided when students look for references from the internet in order to explore subject matter and assignments, by overriding the accuracy of sources, misconceptions will occur. Through the stages of changing the conception described by Posner [10] the questions are given to see the conditions of understanding the concepts that exist in students. Through the answers given from these questions it can be said whether the student is in a misconception or not. Meanwhile, analogical education comics are used as a medium for students to find new logical concepts that are scientific and can be imagined in students' minds. The information provided in these comics can change the condition of students' misconceptions into conditions in scientific conceptions. The condition of students' misconceptions and scientific conceptions can be accessed through the answers to the questions given, so that in the end it can be seen how many students are still misconceptions and who are already with the conditions of scientific conception. From the description above, the purpose of this study is to find out how the form of analogy education comics and its use in changing students' misconceptions into scientific conceptions.

1.1. Educational Analogy Comic Structure

Analogy Education Comics which aim to overcome student misconceptions refers to the making of Text Based Analogy (TBA), [35] made in five parts that have been planned with conditions of dissatisfaction, clarity, reason and fruit as developed by Posner [10] then by including an analogy approach in the concept explanation section in the text as described in [36,37].

The following is the structure of the Educational Analogy Comic which is oriented to overcome student misconceptions, including:

a. First, identify student misconceptions that reveal the conceptual images that are in students' minds. This section aims to make students realize that they lack knowledge in answering the questions in the first section. The cases that are revealed in the comics must also be related to everyday life. This first part is a step towards students' dissatisfaction with the conceptions that exist in themselves.

b. Second, displaying concept errors that often occur along with evidence that the concept is indeed wrong and students realize it. This aims to make students question the conceptions that exist in themselves and see the shortcomings of ignorance. In other words, this is the part where the conflict is made to strengthen students' dissatisfaction with the conceptions that exist in themselves.

c. Third, in this section the scientific truth about the concept addressed is given very clearly and must be understood in order to make knowledge permanent. The explanation of scientific truth in this section is:

1) Introducing the target concept to students.
2) Remind students of concepts that are used as an analogy tool, these concepts can come from objects, processes, or events that students must already know.
3) Identifying the relevance of the concept which becomes an analogy tool with the concept being targeted.
4) Then students are invited to connect similar things from the concept which is an analogy tool with the concept that is the target.
5) Students are also led to know the part that is the limitation between the concept being an analogy tool and the concept that is the target, so that in the end students are expected to draw their own conclusions in their minds.

d. Fourth, when students understand the difference between misconceptions and scientific explanations, they are asked to express their opinions. This section aims to measure how much awareness has been raised and see if students still have question marks in their minds.
e. Fifth, this section aims to understand whether students have understood comics well. Students are assisted by the teacher to draw conclusions from comics. With the new existing concept, students are expected to be able to transfer that knowledge and be able to solve new problems so that the newly acquired knowledge becomes permanent.

2. Experimental Method

The method used in this research is the Pre-Experiment Design research method [38]. By considering research needs and time constraints, the sample selection was not carried out randomly, but it was taken from pre-formed groups, namely classes.

Research design is a design for how research is carried out. The research design used in this study is the One-Shot Case Study Design. Where there are groups that are given treatment with the Educational Analogy Comic and then the results are observed. [39], research design can be seen in table 1.

| Treatment | Observation |
|-----------|-------------|
| X         | O           |

Explanation:

X: One group used the Educational Analogy Comic treatment with the material Simple Electrical Chains
O: Observation

The population of this study were students in grade 9 at one of the secondary schools in South Jakarta for the 2020/2021 school year, totalling 30 people. The sampling technique was purposive sampling, in which the samples studied were students who had learned electrical circuit material and experienced misconceptions on simple electrical circuit material detected using the Simple Electrical Circuit Diagnostic Test (SECDT). As an indicator that explains that students are in a state of misconception is when students believe that the size of the battery stone will affect the brightness of the lights in a series.

Figure 1. Research stages

As described in Figure 1, this research was conducted in 4 stages, namely the needs study stage, the design stage, the development stage and the data processing and reporting stage.
2.1. Needs study stage

This stage is a stage of in-depth exploration of the issues being studied. Some of the activities carried out at this stage are literature studies of journals and research reports regarding student misconceptions on the concept of electric circuits, the role of comics in changing conceptions, text and comics with an analogy approach, and subject matter for class 9 MTs electrical circuits, analysis of the availability of comics in the concept of electrical circuits, determining the types of students' misconceptions on the concept of electrical circuits, as well as the preparation of research instruments, instrument validation, and improvement.

2.2. Design stage

As described in figure 2, this research was conducted in 4 stages, namely as follows

1) Preparation of an initial comic draft, at this stage a comic design is carried out which will be developed using an analogy approach with the aim of overcoming misconceptions. Initial drafting referred to students' misconceptions and the concept of electrical circuits.

2) The validity of the comics consists of content validity and construct validity. Content validation consists of the aspects of the suitability of the physics content, the analogy approach and the conceptual conversion approach. Meanwhile, construct validation consists of aspects of language and conformity with the research objectives. The comic validation was carried out by three experts or experts. The validation results determine whether the comic is appropriate or not to be used in learning.

3) Evaluation and revision, comics that have passed the validation stage will be corrected according to the suggestions of experts.

4) Compiling analogy comics to overcome misconceptions on Microsoft Sway and compiling feed questions on Microsoft Form in it, so that they can be used for distance learning.

2.3. Implementation stage

After analysing the results of the validation of the instruments from the experts, the implementation stage was carried out in October 2021 at one of the Islamic public schools in South Jakarta.

2.4. Data processing and reporting stage

At the data processing stage, the first part of the comic is an expression of students' misconceptions and the last part is an expression of new and scientific knowledge obtained from reading comics. If students experience a change in concept from misconception to having scientific knowledge and they feel confident, then the student is said to have been able to overcome the misconception, however, if the student is from the misconception and persists in his belief, the student is said to be in a state of misconception even though he has read comics.
3. Result and Discussion

3.1. Result

3.1.1 Analogy Educational Comics Instrument

Part I

Let's Study Series Electrical Circuits

Nafis and Nayla discuss the use of batteries in simple electrical circuits.

Figure 3. Scene 5, page 2 of the comic

As shown in figures 3, Nafis found that the small flashlight does not shine brightly but the big one can shine brightly. In your opinion, from figures 4 and 5 below, which lamp will light up brighter when the switch is ON, if each battery is in a state that has just been used? Then give your reasons!

Figure 4. The circuit using AA size battery

Figure 5. The circuit uses battery size D

Part II

How about your answer in part 1 earlier? Is your answer the same as the statement below. The following statements are answers that are often expressed in response to the questions given in part I earlier.
"The light in the circuit in figure 5 will be brighter, because it uses a larger battery size, namely D size, which has a larger electric current and voltage."

How about the answers you gave earlier? Is it the same as the statement above? And are you sure of the truth of the statement above?

If your answer is the same as the statement above and you believe it is true, then that answer is wrong and you are in a state of misconception. All right, now look at the following conversation very carefully.

**Part III**

![Figure 6](image.png)

**Figure 6.** Scene 4, page 4 of the comic

Figures 6 are part of the comics that serves as an analogical scientific explanation of the events that occurred. The analogy explanation in the comics above has limitations, including when the switch is opened in the electric circuit, the electric current will stop flowing, but the opposite is when the tap is opened on the pipe, the water will flow, when the switch is closed, the electric current will flow, but the opposite is when the tap is closed then the water will stop flowing, and the size of the battery cannot be compared to the size of the water pump.

a. From the explanation given in the comic, it can be concluded that the characteristics of a series are:

b. Electric current flows with a single path in the circuit, the amount of current present in all devices in the circuit is the same.

c. The total resistance that is in the circuit is the sum of all the obstacles along the circuit.

d. The amount of current in the circuit equals the voltage provided by the battery divided by the total number of resistances in the circuit (Ohm's Law).

e. Ohm's law also applies separately in calculating the amount of voltage on each device that has a different resistance. Of course, it takes a greater voltage to face greater resistance and vice versa.

f. If one device is damaged in the circuit, the current in the circuit will stop and all existing devices will not function. The size of the battery does not affect the brightness of the lights on the circuit but the size of the battery does affect how long that brightness can be obtained. Using a high-voltage battery or adding a battery to the circuit will result in the brightness of the lamp on the circuit, regardless of the size of the battery [40].
Part IV
Is your answer to part I different from the information contained in the comic? If 'yes' will you change your mind? Express your opinion based on information from the comic that has been read earlier at the points below!

Part V
To find out your views on the information obtained, after reading the comic, answer the following questions!

![Figure 7. Electrical circuit in series with 1 battery size D](image7.png)

![Figure 8. Electrical circuit in series with 2 batteries size AA](image8.png)

Please, pay attention for images 7 and 8 above!
The resistance value of each lamp and the voltage value of each battery in figures 7 and figure 8 are the same. If the resistance in the battery is ignored, which light in the circuit will light up brighter when the switch is ON? Then give your reasons!

3.1.2. The Use of Analogy Educational Comics in Overcoming Misconceptions. The answer to all students to the question Part 1 is that the light in the circuit in figure 6 is brighter, because it uses a larger battery size, namely size D which has a larger electric current and voltage. This proves that the detection results of the SECDT instrument are correct, namely 30 students who were sampled were in a state of misconception. Students' answers in Part 2 also reinforce the condition of misconceptions, because students give statements of confidence in the answers given in Part 1. In Part 2 students are expected to enter the dissatisfaction stage [10] so that they feel interested in reading scientific explanations in Part 3.

When students answer the questions in Part I, it can be observed that they state that the size of the battery will affect the brightness of the lamp because the value of the voltage and electric current depends on the size of the battery. They also believe that the electric current that flows in the circuit comes from the battery regardless of the difference in the level of potential difference at each pole in the battery.

Entering Part 3, a scientific explanation is given by including an analogical approach, so that in Part 4 students find and understand the new concepts presented. In the end in Part 5 students can answer the
questions given because new ideas have been formed. Students are able to solve problems in the form of questions in Part 5 with this new concept. The question at the end has an answer that is only implied in the comic, this is to see whether the students understand the concepts given in the comics well so that they can apply them in other situations.

By analysing the students’ answers in Part 4 and 5, it was found that 19 students or 63% were aware of their misconceptions and gained new knowledge and believed in the truth of scientific explanations presented in comics. Meanwhile, 11 students or 37% were still in misconception. The group selected in this study were students who had studied electrical circuit material and were identified to have misconceptions, so that the focus of this study was focused on the function of Educational Comics with Analogy in overcoming student misconceptions.

3.2. Discussion

From the research results, it can be seen that educational comics are quite useful in overcoming misconceptions that occur in students. It is in accordance with the research of experts that the analogy approach found in comics can help students to turn misconceptions into scientific conceptions by activating their misconceptions, generating dissatisfaction, and presenting correct, sensible and reasonable explanations [3]. The use of cartoon or comic concept work concepts with simulations can change conceptual in subject matter, can improve conceptual understanding and improve misconceptions that occur [27]. The use of these comics in overcoming misconceptions is important because their conceptions are different from scientific concepts, are latent, difficult to change and detect by teachers [7]. Practically analogue education comics can be used by teachers in science learning as a solution to efforts to overcome misconceptions.

Besides the benefits available, the analogy education comic has not been able to overcome the misconceptions of all students. This can be seen from the fact that there are still some students who still experience misconceptions after being given the analogy education comic. According to experts, misconceptions are very difficult to remove and even permanent [6,7]. One of the causes is the difficulty of students in understanding the material of simple electrical circuits [8].

Whether the analogy concept that represents the object is unknown to the students, so when building a connection with the scientific concept, the results of their observations differ from the expected results. With the existing limitations, it is necessary to combine analogy education comics, for example, with video media in explaining scientific concepts so that it will further assist students in accelerating the process of changing conceptions.

4. Conclusion

Analogy Educational Comics are comics that are structured based on an approach to conceptual change and analogies. It was found that comics can effectively help students in overcoming their misconceptions experience. Therefore, it is advisable for Physics teachers to be active in making Educational Comics with Analogy in other Physics materials so that students' misconceptions can be overcome, especially during the current pandemic where students are longer interacting with the internet.

References

[1] Holyoak K J 2012 Analogy and Relational Reasoning (Oxford University Press)
[2] Chiu M-H and Lin J-W 2005 Promoting fourth graders’ conceptual change of their understanding of electric current via multiple analogies Journal of Research in Science Teaching Wiley InterScience 42 429–64
[3] Ugur G, Dilber R, Senpolat Y and Duzgun B 2012 The effects of analogy on students’ understanding of direct current circuits and attitudes towards physics lessons European Journal of Educational Research 1 211–23
[4] Senen B A and Ince E 2010 Internet as a source of misconception: “radiation and radioactivity” The Turkish Online Journal of Educational Technology 9 94–100
[5] Zajkov O, Zajkova S G and Mitrevski B 2016 Textbook-caused misconceptions, inconsistencies, and experimental safety risks of a grade 8 physics textbook International Journal of Science and Mathematics Education 15 837–52
[6] Vosniadou, S., & Skopeliti, I. 2014 Conceptual change from the framework theory side of the fence Springer Netherlands 23 1427–45
[7] Gurel, D. K., Eryılmaz, A., & McDermott, L. C A review and comparison of diagnostic instruments to identify students’ misconceptions in science Eurasia Journal of Mathematics, Science & Technology Education 11 989–1008
[8] Pesman, H., & Eryılmaz, A. 2010 Development of a three-tier test to assess misconceptions about simple electric circuits The Journal of Educational Research 103 208–22
[9] Yumusak A, Maras İ and Şahin M 2015 Effects of computer-assisted instruction with conceptual change texts on removing the misconceptions of radioactivity Journal for the Education of Gifted Young Scientists 3 23–50
[10] Posner G J, Strike K A, Hewson P W and Gertzog W A 1982 Accomodation of a Scientific Conception: Toward a Theory of Conceptual Change Science Education 66
[11] M. R. Abraham, E. B. Grzybowski, J. W. Renner, and E. A. Marek 1992 Understandings and misunderstandings of eighth graders of five chemistry concepts found in textbooks J. Res. Sci. Teach. 29
[12] Sinatra G M and Broughton S H 2011 Bridging reading comprehension and conceptual change in science education: the promise of refutation text Reading Research Quarterly International Reading Association 46
[13] Vendetti M S, Matlen B J, Richland L E and Bunge S A 2015 Analogical reasoning in the classroom: insights from cognitive science International Mind, Brain, and Education Society and Wiley Periodicals 9 100–6
[14] Remigio K B, Yangco R T and Espinosa A A 2014 Analogy-Enhanced instruction: effects on reasoning skills in science The Malaysian Online J. of Educational Science 2
[15] Okoronka U A and Wada B Z 2014 Effects of Analogy Instructional Strategy, Cognitive Style and Gender on Senior Secondary School Students Achievement in Some Physics Concepts in Mubi Metropolis, Nigeria American J. of Educational Research Science and Education Publishing 2
[16] Daryanto 2010 Media Pembelajaran (Yogyakarta: Gava Media)
[17] Benjamin D. Jee and Florencia K. Anggoro 2012 Comic Cognition: Exploring the Potential Cognitive Impacts of Science Comics Journal of Cognitive Education and Psychology 11
[18] Symons, C. S. and Johnson, B. T. 1997 The self-reference effect in memory: A meta-analysis Psychological Bulletin 121 371–94
[19] Tekle-Haimanot, R., Preux, P. M., Gerard, D., Worku, D. K., Belay, H. D., and Gebrewold, M. A. 2016 Impact of an educational comic book on epilepsy-related knowledge, awareness, and attitudes among school children in Ethiopia Epilepsy& Behavior 61 218–23
[20] Kim, J., Chung, M. S., Jang, H. G., and Chung, B. S. 2016 The use of educational comics in learning anatomy among multiple student groups Anatomical Sciences Education 10 79–86
[21] Kraft, S. A., Constantine, M., Magnus, D., Porter, K. M., Lee, S. S.-J., Green, M., Kass, N. E., Wilford, B. S., and Cho, M. K. 2016 A randomized study of multimedia informational aids for research on medical practices: Implications for informed consent Clinical Trials: Journal of the Society for Clinical Trials 14 94–102
[22] Matteo Farinella 2018 The potential of comics in science communication Journal of Science Communication 17
[23] Bach, B., Kerracher, N., Hall, K. W., Carpendale, S., Kennedy, J., and Riche, N. H. 2016 Telling Stories about Dynamic Networks with Graph Comics Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems– CHI ’16 3670–82
[24] Bach, B., Riche, N. H., Carpendale, S., and Pfister, H. 2017 The Emerging Genre of Data Comics IEEE Computer Graphics and Applications 37 6–13
[25] Ertugrul Ozdemir 2017 Comics in modern physics: Learning blackbody radiation through quasi-history of physics Studies in Educational Research and Development 1 41–59
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