JPSI 9(1):151-167, 2021
Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)
e-ISSN: 2615-840X p-ISSN: 2338-4379

Development of Comic-Based Learning on Reaction Rate for Learning to be More Interesting and Improving Student's Learning Outcomes

Sri Adelila Sari*, Nur Fatni Amirah Harahap

Chemistry Department, Faculty of Mathematics and Science, State University of Medan, Indonesia

*Email: sriadelilasari@unimed.ac.id

DOI: 10.24815/jpsi.v9i1.18852

Article History: *Received: December 7, 2020* *Revised: January 7, 2021*
Accepted: January 10, 2021 *Published: 16 January 16, 2021*

Abstract. Teachers often use projector media in classroom learning. Rarely do they want to develop and vary learning media with the aim of making the learning process more interesting. Finally, the lack of student interest in reading textbooks results in low student learning outcomes, which are not the focus of teacher attention. This study was aimed to develop comic in the material on reaction rates. The method used was R & D with ADDIE, namely analysis, design, development, implementation, and evaluation. The analysis stage was carried out by analyzing the needs in the form of student characteristics and identifying learning media. The design stage was included plot design, character, and scenario. The design results were then developed, then the comic was given to validators to the feasibility test. The implementation stage was carried out at the XI SCIENCE class, Senior High School LAB IKIP Al Washliyah Medan. Furthermore, student learning outcomes were measured at the evaluation stage by using tests. The results of this study found that comic could be developed by the eligibility criteria of 93.29 percent with very good. Students were very enthusiastic about chemistry comic. Student learning outcomes were obtained an average of 81.07, which means that the minimum completeness criteria value was of 75. This study concluded that this comic was very suitable for use in chemistry learning, especially in the material reaction rate and student learning outcomes were achieved good criteria.

Keywords: Development, comic-based learning, reaction rate, and learning outcomes

Introduction

Fun learning has an important role in the ongoing teaching and learning process in which there is a strong relationship between educators and students without feeling forced or depressed. The success of a teaching and learning process can be achieved if its aspects run in harmony between students, educators, and learning resources (Fawaidah & Sukarmin, 2016).

Brouillette & Lubell (2019) provided motivational exercises to engage students to study the nature of the elements, by exploring alternative pedagogical approaches to connect the science behind the comic stories of heavy-metal heroes. The results of this study found that comics could be inspired students to examine the characteristics of superheroes through a chemical perspective fiction of the facts. In addition, Koutníková (2017) did analysis and reflection on working with comics by students in preschool teacher

training program. This study concluded that comics could be very helpful in making science concepts interesting and understandable for preschoolers.

Research conducted by Affeldt, et al., (2018) on students 'perceptions of using comic-based lab instruction non-formally in the field of water quality chemistry found that students' positive perceptions could be identified with respect to comic-based experimental instruction. Then he emphasized that the use of comics in science education was very much needed. Roswati, et al., (2019) has developed science comic book and implemented in the human digestive system topic learning. Most of students agreed that science comic books helped them in learning through simplifying science concepts and understanding topics that were easier to understand.

Özdemir (2017) has been developed and evaluated the comic strip. It was aimed to contribute to learning about sound related concepts. Based on results, most students believed that comics help learning through simplification of science concept and made storage easier. Apart from that, comic strips also seem to have contributed student enjoyment of science and perceptions of success in science.

The reaction rate was considered difficult by some students, because the reaction rate material contains the two competencies required, namely understanding concepts and counting. One possible way to improve the understanding of concepts in the reaction rate material was to develop learning media which was appropriated to the characteristics of the material being studied (Hapsari, 2017). Media is a tool that can help the teaching and learning process that serves to clarify the meaning of the message conveyed, so that teaching objectives could be achieved well (Daryanto, 2013).

Based on the results of observations made in Class XI at MAS LAB IKIP Al Washliyah Medan, it has been found that the use of instructional media used by teachers was very minimal and limited. Teachers usually only used projector media and never tried to develop existing media for interested learning. In addition, the lack of student interest in reading textbooks was an issue that should be of concern to the teacher. For this chemical reaction rate, the teacher placed more emphasis on learning to read and memorize concepts and rarely uses variated methods. The learning strategy used by the teacher was suspected to not foster students' interest and motivation, so that the learning outcomes obtained by students were not yet optimal. Based on these observations also, chemistry teachers in their learning more often used one-way learning methods.

The development of comic might be an alternative solution in this case, because the potential for learning to use comics would be maximized the sense of sight. Besides, the emphasis on the visual, this comic was also supported it as a medium for learning to be more enjoyable. Comic could be used in the two-way learning process, as a teaching aid and learning media that could be used by students themselves (Saputro, 2015). It was hoped that through comic, students could be motivated to learn, search, and develop their own understanding, so that what they read and learn were not as easily forgotten as when reading comics in general, and ultimately would be provided optimal learning outcomes.

The limits of completeness of student learning outcomes according to chemistry at SMAN 9 Banda Aceh was found to be 65. The cognitive results of the application of comic-based learning produce the highest and the lowest scores were of 85 and 45, respectively, however the average value was of 74.3. Based on these results, the number of students those who achieved mastery from the comic-based learning process was of 26 students, with a percentage of 86.67, the application of comic-based learning on reaction rates topic could be improved student learning outcomes (Sari, et al., 2011). The comic was very feasible to use, as evidenced by the average rating score of comics (very good) (Hartanti, 2009). The test of the validity of media display by one media expert lecturer was obtained by 99 percent and by teachers was of 91 percent, respectively. While the validity test of the contents of media material by one chemistry lecturer obtained a result of 100 percent,

and from 10 students was of 91 percent. The validation and small group trials showed that the comic learning was appropriate to be used as a learning medium (Hayati, 2017).

The results of a small group trial to class XI students of SMA Negeri 6 Kota Jambi on the webtoon comic learning media on thermochemical topic showed very good responses and positive comments from students (Putri, 2019). There were differences in learning outcomes between students who learned to use and without comic. The use of comic media had an effect of 27.04 percent on the improvement of student learning outcomes in the nomenclature of chemical compounds (Putri, et al., 2015). The assessment of media experts, material experts and users of comic learning media products on chemical bonding material in a row was very good and the results of student responses obtained was also very good (Minarni, et al., 2019). The comic media on chemical bonding material could be increased in learning outcomes (Prihanto & Yunianta, 2018).

Difficulties in understanding chemical materials were generally caused by the process of delivering suboptimal information between teachers and students. Therefore, it was necessary to develop learning media that can be used on the reaction rate material, so that the learning outcomes obtained by students exceed the minimum completeness criteria. Based on the problem, a comic book was developed for the reaction rate topic that was used in Class XI Students in MAS LAB IKIP Al Washliyah Medan.

Methods

Sampels were take by purposive sampling technique from 28 students at MAS LAB IKIP Al Washliyah Medan, in class XI SCIENCE in odd semester 2019/2020 academic year, from June to December 2019.

The comic was developed with ADDIE model, *i.e*., analysis, design, development, implementation and evaluation. The data of feasibility of comic was collected using feasibility assessment sheet. In addition, student's learning outcomes were collected by tests.

The feasibility comic was analyzed using percentage, as well as learning outcomes. The percentage of appraisal of the feasibility of comic media is presented in Table 1.

Tabel 1. Percentage Score for Comic Feasibility

	Percentage rate	Criteria
1.	81-100	Very decent
2.	61-80	Feasible
3.	41-60	Fair enough
4.	21-40	Not eligible
5.	0-20	Very inadequate

Results and Discussion

Analysis

The main activity at this stage was analized the needs, including materials, characteristics of students and learning media in class XI MAS LAB IKIP Al Washliyah Medan. In the initial observations, it was found that the reaction rate material was be considered difficult to be understood. In addition, most students were not be interested in paying attention to the lessons. Students were also less actively involved in the teaching and learning process. Students in the class also did many other activities, such as invited

friends beside them to tell stories and did not pay attention to the teacher explaination. It has been observed that one of the reasons might be the lack of use of instructional media that attracts students' attention. The learning media used were still limited to the use of printed books and student worksheets. It might be due to the number of school operational assistance fund books (BOS) was also very minimal. Before chemistry learning process was started, then teacher must be taken the BOS book to the teacher's office and then distributed it to students. The distribution of this book was also uneven because those books were also limited, so the students only used the worksheet as a learning medium.

Therefore, it was necessary to provide learning media that could made students more interested and motivated to learn. One of the media that could be used namely comic-based learning media. This comic allowed students to have an active role in a more interesting way to learn. Then the curriculum, needs and learning objectives analyses were carried out.

The following were the results of the analysis phase:

a) Curriculum Analysis

At this stage, an analysis of the curriculum used in MAS LAB IKIP Al Washliyah Medan, namely Curriculum 13. The contents of the material in this comic were directed to students to be more active and assisted students in visualizing the subject matter to more easily understand concepts. Reaction rate topic was difficult for students to understand, due to alot of calculations, so students were less interested in learning. In addition, this topic also invited students to do practical work and not only that, this topic was also very much related to everyday life. Based on the above, the comic was expected to help students understand the reaction rate more easily. This media could also be attracted students to be more active in learning and even explore events which could be related to the material reaction rates in everyday life.

b) Requirements Analysis

Based on the need of analysis, it was found that students need interesting learning media, so they did not feel bored and were more active during the teaching and learning process. Therefore, students were more eager to understand and learn the learning material being taught. By considering the condition of students during the learning process there were several things that became students' needs. These needs were efforted to: (i) develop good, interesting and entertaining story content to have the same quality as comics students have read, (ii) design good and unique comic characters so that they were interesting from the visual side, (iii) fill comics with educational content but still entertaining, and (iv) balance the learning strategies implemented so that the expected learning targets could be achieved. Comic was one of the learning resources that was expected to enrich other learning resources, giving a more conducive feel to learning in the classroom. In addition, comic was expected to be used inside and outside the classroom.

c) Analysis of learning objectives

At this stage, observations were made in class XI SCIENCE MAS LAB IKIP Al Washliyah Medan, with 28 students attended. During the learning process there were students who did not pay attention to the teacher, chat, and did not have the initiative to work on the practice questions. Teachers who did not use learning media optimally, learning was only focused on textbooks, even though 50 percent of students did not have textbooks. The role of the teacher in the learning process was still dominant, which was not in accordance with the curriculum used in schools. K-13 required students to play an active role during the teaching and learning process and the teacher was only acted as a facilitator.

Therefore, teachers were expected to apply learning media that were interested, fun and made students easier to understand the material being studied. Comic development

was expected to meet the needs of students of MAS LAB IKIP Al Washliyah Medan namely the availability of interesting, creative and innovative chemistry learning comic media, so that it could help students understood concepts of reaction rate topic. The topic could be developed in accordance with the syllabus and lesson plans. It has been found that the assessment of experts obtained in the very feasible category. The validity test of media was found to be a very high validity and practicality category (Fajriah & Anggreini, 2016; Elfiana & Azhar, 2019; Fahmidani, 2016).

Roswati, et al., (2019) sought the analysis on four aspects of science comics, *i.e.,* consist of artwork, science content, language, and uniqueness. Those aspects would be used as the main aspects to help the reviewers and the students focused on giving feedback and suggestion through science comic development. However, Özdemir (2017) found in their analysis about the difficulties to find and adapt appropriate comic strips useful for instructional purposes, because most of them were irrelevant. Affeldt, et al., (2018) found an issue was not motivating or personally interesting to students, they skim or omit reading passages and try to finish the text as quickly as possible. It was found the decrease in average reading skills among students. They suggested comics would be better than conventional text-based instructions. Brouillette & Lubell (2019) found that innovative methods were becoming more vital to spark interest in scientific subjects and published to date supports active learning as the preferred, empirically validated teaching practice to increase student performance on examinations and concept inventories. The results of the analysis summary served as a guideline for developing comic learning media concepts for chemistry subjects that would be further developed. The development of chemistry comic was aimed to improve student learning outcomes in chemistry subjects. By learning using comic, it was expected that students could played an active role during the learning process and understood the concepts of reaction rates more easily.

Design

The design phase was the stage of product design (media) to be made which included plot design, character design, and scenario. The steps in the process of the comic design were as follows:

i. a picture was scetched and the number of characters was determined in accordance with the plot. The theme of the desired story and character was drawn manually using a pencil on a piece of A4 paper.
ii. thickening (inking) was done after the sketch of the image has been made, so that when it scanned could be seen clearly.
iii. the sketch of the bolded image was then scanned, so that it could be edited using Photoshop CS3.
iv. after the sketch was scanned, then the dialogue of the conversation was inserted between the characters into the comic sketch using Photoshop CS3.
v. after the conversation was inserted, the comic was colored by using Photoshop CS3 then saved in the form of jpg.
vi. the results of the comic were then combined with Microsoft Word 2007, after the images were inserted, the topic of the reaction rate was added between the comic images.

After all the steps in designing the comic, there were several needed, such as follows:

a) Tools, Materials and Formats

The tools used in the development of comic include laptops, pencils, black markers and printers, the material used is A4 paper. The appearance format and contents of comics were designed using a computer program. For typing dialogs, drawing and coloring, therefore Photoshop CS3 was applied as well as Canva Online. The contents of the comic were reaction rate topic in Indonesia language, to easier for students to understand.

b) Plot Design

The design of the plot was carried out to determine how the story line and events from the comic, so that it became an interesting, intact and structured story. The plot to be used as a basis for reference was as follows:

i. Main actors
   The story would be taken place around two high school teenagers named Nia, Tira who had their own characteristics and personalities and a chemistry teacher named Ms. Sarah.
ii. Theme
   The theme in the chemistry comics learning media was education and the slice of life.
iii. Story direction
   The direction of the chemistry comic story would be focused on school life and the application of chemistry in particular the matter of reaction rates with its application in everyday life.

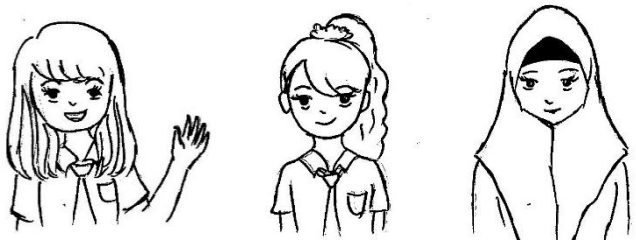
c) Design

The physical appearance, personality and other details needed from the characters were based and adjusted to the information from the plot design. The personalities and characteristics of the main characters in the story can be seen in Table 2.

Tabel 2. Characteristics of Main Characters

No.	Character	Characteristic
1	Nia	likes chemistry the most
2	Ms. Sarah	favorite student
3	Tira	friend of Sarah, loving chemistry lessons, offended easily
4	Sarah's chemistry teacher	good, friendly, patient and like to smile, always associate subject matter with daily life

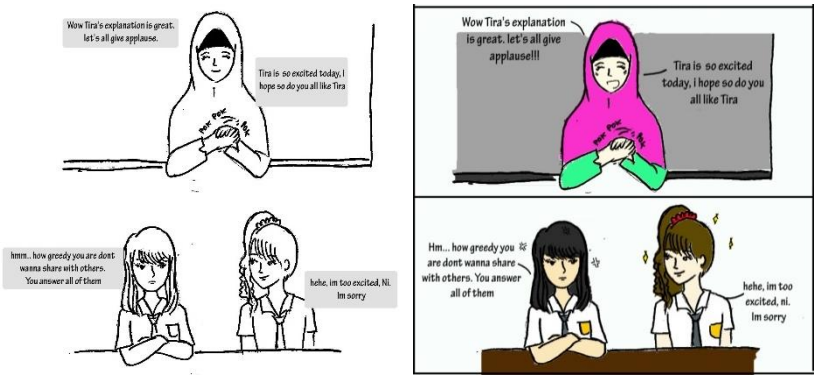
This comic sketch was designed manually by drawing comic sketches on A4 paper then thickening the drawing with comic markers. After the image was thickened with a comic sketch marker, the comic was removed, so that the resulting image was cleaner. Furthermore the comic image was scanned so that words or dialogs could be inserted into the comic. The appropriate character physical appearance was designed and other details needed in the rough drawing as shown in Fig. 1. This comic would be made into a book with a size of 20 x 14 cm. The words or dialogs to the comics were created using Photoshop CS3 application, as shown in Fig. 2. After the dialogue text was created, the comic was colored using the Photoshop CS3 application, as shown in Fig. 3.



(a) (b) (c)

Figure 1. Sketch of comic characters: (a) Nia, (b) Tira, and (c) Sarah

Figure 2. The dialogue text



(a) (b)

Figure 3. Comic Coloring: (a) Before, and (b) After

The design stage was the stage of product design (media) made, including plot design, character design and scenario making. The design of the preparation of basic competencies, indicators and learning objectives of the material was designed into the preparation of the material, then continued with the comic concept (Fahmidani, 2016).

d) Designing Evaluation of Learning Outcomes

At this stage, the test items were arranged. It would be given at the end of the class. The evaluation in the form of a written test with multiple choice questions with a total of 10 questions.

Roswati, et al. (2019) did the design after the analysis of the science content. The stage consisted of writing the first outline of the comic, making the panels and storyboard, drawing the comic, reviewing by an expert, and revising the comic. After writing scenarios, all episodes were drawn by the researcher who was a comic artist (Özdemir, 2017). The same way, Affeldt, et al. (2018) designed the text and instructional material. The figures represented different ethnic backgrounds and were gender balanced.

Development

At the development stage, the comic was carried out to expert validators and chemistry teachers who were conducted an evaluation of the comic. Learning media was said to be good for use if it had gone through several stages of assessment. The purpose of this media assessment was to find out the quality of the product before it was implemented to the students. The assessment was done using an instrument in the form of a questionnaire. All the data and services would be used as consideration for improving the chemistry learning media comics. Fig. 4 shows the assessment results from expert validators and chemistry teachers. Based on Fig. 4 the cover of the comic consists of: title, class, subject, name of the compiler and there was a picture that matches the reaction rate material. The arrangement of the cover designed on *Canva Online* was edited using Photoshop CS 3.

(a) (b)

Figure 4. Cover: (a) before, and (b) after edited

a) Evaluation of Expert Validators

Expert validator assessment was conducted by competent lecturers in accordance with the media and the content presented. The assessment by the material expert validator was reviewed from the display aspects, content and presentation aspects. The results of the evaluation of the comic feasibility can be seen in Fig. 5. The category of feasibility was found to be very eligible, means that the comic was appropriate to be used.

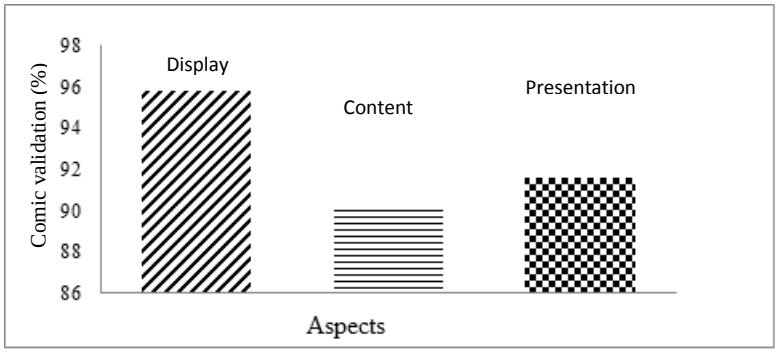


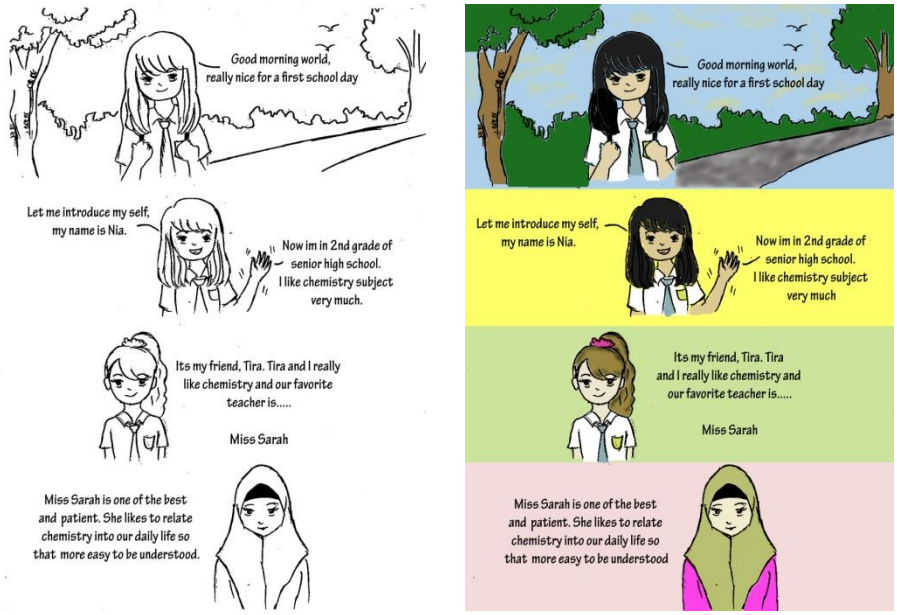
Figure 5. Comic Validation from Lecturer

The results of the comic feasibility assessment from the expert validator in the questionnaire sheet conveyed that the chemistry comic as a whole was good and worth testing. But before it's being implemented, some advices were as follows: (i) improve the margins and font sizes in the comic were needed to be enlarged, so the comic to be easier to read, (ii) select the writing font according to the comic and be consistent, and (iii) the content about the reaction order has not been fully explained more with pictures.

After the chemistry comic was evaluated, then some revise had been improved as follows:

i. Fix the margins and font sizes in the comics

Before margin was revised, the sizes were top to 0 cm, left 0.5 cm, bottom 1 cm; and right 0 cm. When it was printed, the comic was not clearly visible or cut off. Therefore, margins were adjusted to sizes top of 0.5 cm, 1.5 cm left, bottom 1 cm; and right 0.5 cm. The margin and size of the writing form before being revised and after are shown in Fig. 6. In addition, before revised was done, font sizes in the comic were made with 15 and 18. These comic sizes were inconsistent, expert validators suggested that comic sizes should be consistent, so the size of letters in comic was adjusted to 21.



(a) (b)

Figure 6. Margins and Letter Size: (a) Before, and (b) After Revised

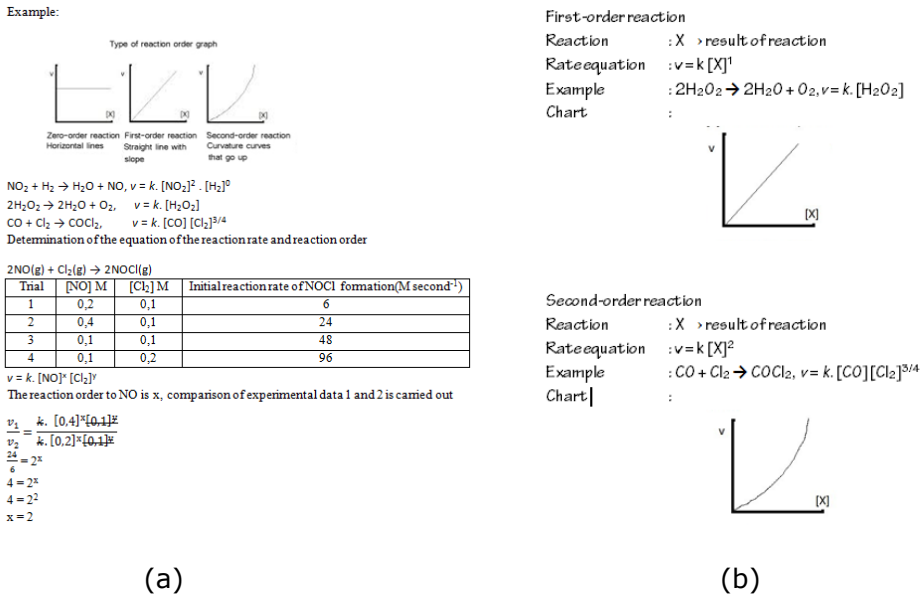
ii. Choose Writing Fonts According to Comics and Consistency

The comic font chosen was not very interesting, so it must be changed to make it better. Initially it was less consistent because used Tekton Pro and Times New Roman for the writing font. In order for the comic font to be better, the expert validator suggested fonts to be the same, namely Tekton Pro only. Fonts of writing before revised and the results of improvements to this writing font can be seen in Fig 7.

Figure 7. Fonts Types: (a) Before, (b) After Revised

iii. Material About Reaction Rate was not Fully Explained with Pictures

Explanation of material about the reaction rate was less detailed, validator experts suggested that the determination of the reaction order be explained with pictures. Based on the suggestion, then the improvements has been done, as shown in Fig. 8.



(a) (b)

Figure 8. Reaction Order: (a) Before, and (b) After Revised

Suggestions and input from expert validators both in writing and verbally as much as possible fulfilled, so that this learning media could be a good and decent learning media.

b) Chemistry Teacher Assessment

The comic assessment was conducted by chemistry subject teachers at MAS LAB IKIP Al Washliyah Medan. The evaluation of chemistry comic was reviewed from the aspects of the display, contents and the presentation. The results of the appropriateness assessment by the teacher was in a very appropriate category, as can be seen in Fig. 9.

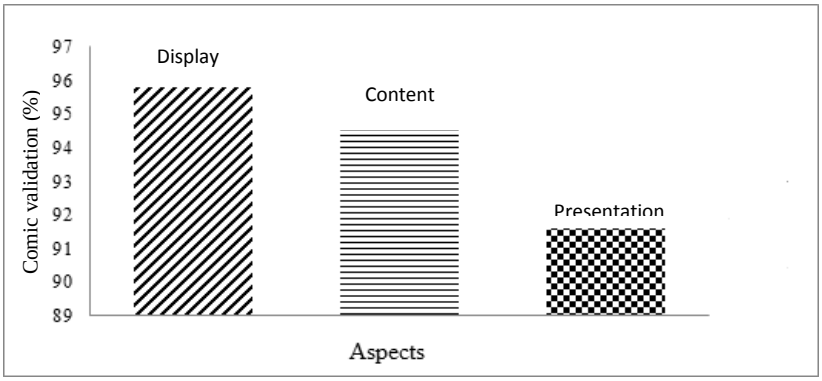
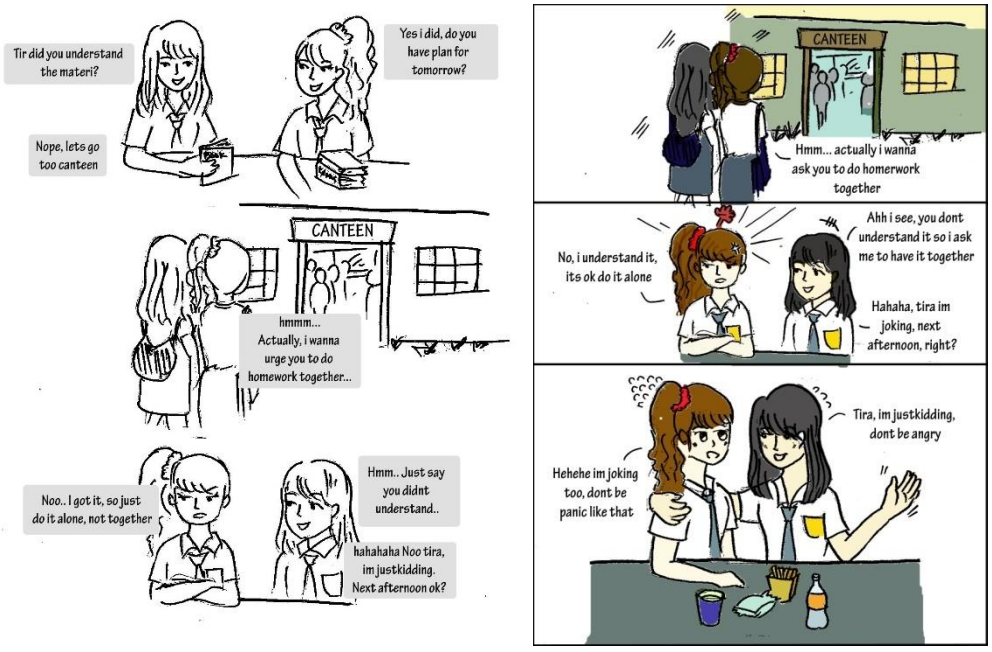


Figure 9. Comic Validation from Teacher

As a whole the feasibility assessment of the comic from chemistry teachers was found to be good. The material presented was already relevant to the reaction rate material and completed. It has been suggested about adding color on the pictures to make it more interested. All suggestions and input from the chemistry teacher both in writing and orally as much as possible were corrected. Suggestions for coloring the comic before and after being colored can be seen in Fig. 10.



(a) (b)

Figure 10. Comic staining: (a) Before, and (b) After being colored

It was consistent to findings that data from each component by the validator obtained was a very high category and the presentation component as well (Elfiana & Azhar, 2019; Fahmidani, 2016). Previous studies were also developed comics such as Koutníková (2017). Comic was developed with some characteritics like scientific ideas on visual, text was minimum, the ideas were applied to every situation. Brouillette & Lubell (2019) designed the Iron Man to reach out to students by stirring scientific interest and triggering discussion as a preamble to the following active learning 'Elemental Superhero' class project.

Implementation & Evaluation

Before conducting the application of developed comic, researchers conducted a feasibility assessment of learning media with expert validators and chemistry teachers. The results of the assessment of the feasibility of this media found that the chemistry learning media was very appropriate to use. The comic which had been declared feasible by validators, then used for chemistry teaching and learning process, as shown in Fig. 11.

(a) (b)

Figure 11. Implementation of comic: (a) discussion, and (b) learning

The comic was applied as learning media within 90 minutes in two weeks of meetings and followed by 28 students those who were divided into 6 study groups. At the time of the implementation, the students were very enthusiastic about chemistry learning comic. Students read the comic carefully and if there was material that was not yet clear, students were dared to ask questions until they understood the material. In addition, during learning with comic, the classroom conditions were more conducive, because there were no students chatting outside the subject matter. After comic was applied, each group was presented their results of the discussion about what the applications of the reaction rate in daily life. The similiar finding was also stated by Fahmidani (2016) that students were very enthusiastic in learning using comic . During the learning process, no one talks, they understood the material presented in the comic, carefully. In addition, Fajriah & Anggreini, (2016) and Hakim (2018) found that learning motivation of students could be increased and the comic was feasible to be used on a wider scope with very goof category.

Student learning outcomes were obtained from the scores when carrying out the pre and post tests. The pre-test was carried out before and the post-test was after the students learned the reaction rate material using comic. The sample used was one class, namely Class XI SCIENCE which consisted of 28 students. The normality test was carried out and the results showed that the pre and post tests data were normally distributed. When the pre test was completed, it was obtained a minimum value of 10 and a maximum value of 60, so that the pre test average was 36.43. After the pretest was carried out, the learning was continued by using comic. After that, post test was carried out on students by obtaining a minimum score of 60 and a maximum score of 100 in order to obtain an average posttest of 81.07. A summary of the scores can be seen in Figure 12.

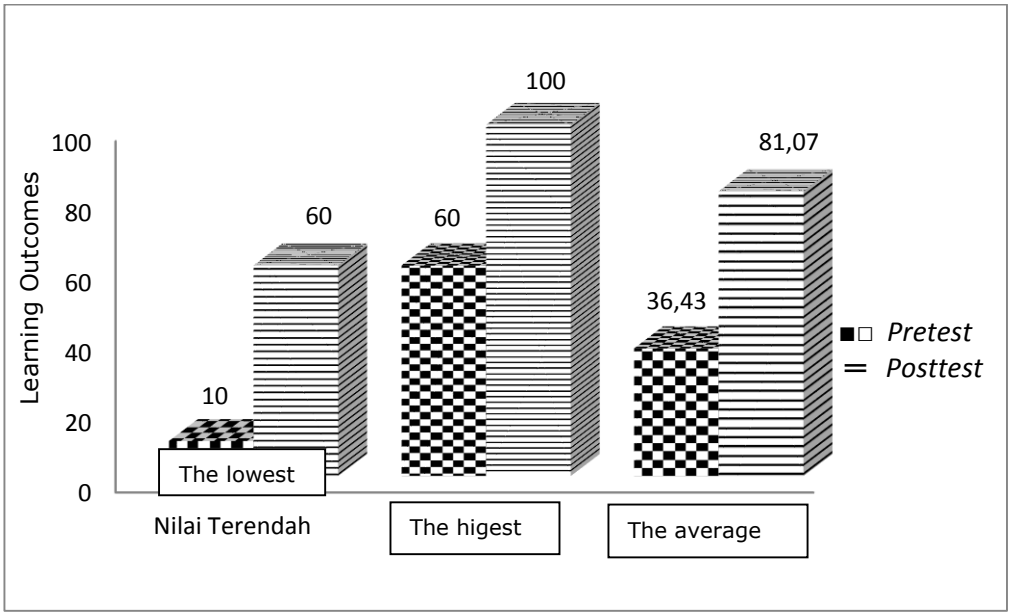


Figure 12. Diagram of Student Learning Outcomes

Based on Figure 12, it can be seen that the pretest scores obtained by students were still below the minimum completeness criteria. After students learned using the comic and did the post test, therefore, learning outcomes were found to be reached the minimum completeness criteria.

This finding was also supported by previous studies. Learning outcomes of students those who learned using media was found to be higher than the control class. The percentage of student learning outcomes was increased in the experimental class (Situmorang, 2014). The similar was also found by Silaban (2018), the flowchart media influenced the improvement in chemistry learning outcomes of class XI students on the subject of reaction rates. There was an interaction between learning models using media and logical thinking skills on student chemistry learning outcomes. The results showed that students those who were taught with the inquiry model with real media on students with high logical thinking ability gave the highest average with virtual media (Hasibuan, 2017). It had been produced a proven comic media in terms of material and media aspects. Comic media were proven to be practical from the assessment of student responses. Comic also proved effective based on the results of the pre-test, post-test and paired samples t-test (Rakasiwi*,* et al., 2019).

In the implementation stage, students were invited to use information learned, in and outside of class, and draw connections among science and fiction. Work to ultimately created an original chemically anchored product (Brouillette & Lubell, 2019). Comics can be very helpful in this effort. But the teacher has an important role in this process (Koutníková, 2017). Overall, very positive perceptions by the students could be identified with respect to comic-based experimental instructions (Affeldt, et al., 2018). It has been

believed that comic strips help learning through simplifying science concepts and contributed students' enjoyment toward science (Özdemir, 2017). Students agreed that science comics could help them to comprehend the science content more quickly because they could enjoy the story and the knowledge with the addition of humour in the comic (Roswati, et al., 2019).

Conclusion

Based on the results of research and analysis that has been done, it can be concluded that this comic-based learning could be developed with the ADDIE model. The eligibility criteria of comic were found to be 93.29 percent with very good criteria. Students were very enthusiastic about the comic. Student learning outcomes obtained an average of 81.07, which means that the minimum completeness criteria value was 75. This study concluded that this comic was very suitable for use in chemistry learning, especially in the material reaction rate and student learning outcomes were achieved good criteria.

Acknowledgements

Acknowledgments are addressed to class XI SCIENCE Senior High School LAB IKIP Al Washliyah Medan that have been collaborated to be the object of this study.

REFERENCES

Brouillette, Y. & Lubell, W.D. 2019. Chemistry in the comics: molecular marvels of iron man. *School Science Review (SSR)*, 100(373):48-54.

Daryanto. 2013. *Learning media: its role is very important in achieving learning objectives*. Yogyakarta: Gava Media.

Affeldt, F., Meinhart, D. & Eilks, I. 2018. The use of comics in experimental instructions in a non-formal chemistry learning context. *International Journal of Education in Mathematics, Science and Technology*, 6(1):93-104. doi:10.18404/ ***ijms***.380620

Efliana, R. & Azhar, M. 2019. Development of student worksheets (LKPD) reaction based structured inquiry class XI high school. *Edukimia Journal*, 1(3):53-60.

Fahmidani, Y. 2016. The effect of problem-based learning models with problem-based worksheets on chemistry learning outcomes of class X of SMA Negeri 1 Kediri. *Thesis*. Mataram.

Fajriah, Z.L. & Anggereini, E. 2016. Educomics development as learning media based character education on the interaction of the cost of living and the environment in junior high school. *Biodik*, 2(1):27-33.

Fawaidah, H. & Sukarmin. 2016. Development of media chemic (chemistry comic) as learning media on chemical bonding materials for class X high school students, *UNESA Journal of Chemical Education*, 5(3):621-628.

Hakim, A.F. 2018. Development of digital comics as a learning media for international payment instruments in open economy materials. *Journal of Education and Economics*, 7(3):204-212.

Hapsari, N.D. 2017. Effect of student activity sheets based on 5E learning cycles on reaction rate materials. *Research Journal*, 21(1):70-75.

Hartanti, R. 2009. Development of chemistry comics learning media for high school/MA class XI odd semester on main material reaction rate. *Thesis*, Universitas Negeri Yogyakarta.

Hasibuan, S.K. 2017. The effect of inquiry learning model using media and logical thinking ability on student chemistry learning outcomes on reaction rate material. *Doctoral Dissertation*, UNIMED.

Hayati, E.N. 2017. Development of electronic comic learning media on thermochemical materials for students on topic reaction rate of class XI of SMAN 9 Banda Aceh. *Thesis*. Syiah Kuala University.

Koutníková, M. 2017. The application of comics in sciences education. *Acta Educationis.* 7(3):88-98. doi:10.1515/atd-2017-0026

Minarni, Malik, A. & Fuldiaratman. 2019. Development of teaching materials in the form of comic media with 3D page flip on chemistry bonding materials. *Journal of Chemistry Education Innovation*, 13(1):2295-2306.

Özdemir, E. 2017. Development and evaluation of comic strips about sound. *International Electronic Journal of Elementary Education*, 9(4):837-850.

Prihanto, D.D. & Yunianta, T.N.H. 2018. Development of mathematical comics media on fractions for grade V elementary school students. *Maju*, 5(1):79-90.

Putri, E.Y., Enawaty, E. & Lestari, I. 2015. Effects of the use of comic media on student learning outcomes on nomenclature materials for chemical compounds. *Thesis*, Tulungagung IAIN.

Putri, H.A. 2019. Development of comic learning media webtoon thermochemical material class XI MIA SMA Negeri 6 Jambi City. *Thesis*, Jambi University.

Rakasiwi, N., Wahyudi & Indarini, E. 2019. Development of comic media using the picture and picture method to improve class IV mathematics literacy skills. *Aksioma: Journal of Mathematics and Mathematics Education*, 10(1):60-70.

Roswati, N., Rustaman, N.Y., & Nugraha, I. 2019. The development of science Comic in human digestive system topic for junior high school students. *Journal of Science Learning*, 3(1):12-18

Saputro, A.D. 2015. Comic application as learning media. *Muaddib*, 5(1):1-19.

Sari, S.A., Mariamy, & Mahlian, M. 2011. The implementation of comic based learning in improving student learning outcomes on reaction rate topics, class XI of SMAN 9 Banda Aceh. *AIC Proceedings*, November 29-30:152-157.

Silaban, A.G. 2018. The influence of problem based learning (PBL) models with media flowcharts on improving student learning outcomes in class XI high school 1 Manduamas FY 2017/2018 on reaction rate. *Doctoral Dissertation*, Unimed.

Situmorang, A.A. 2014. Development of innovative learning modules through media integration and learning methods to improve student chemistry learning outcomes in teaching reaction rate. *Doctoral Dissertation*, Unimed.