

The development of sets-based chemic media on hydrocarbon material

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ABSTRACT

Learning media is a tool that is inseparable from the learning process in the world of education, especially in the current era of the media world which is increasingly utilizing media innovation. This research is a development research that aims to develop hydrocarbon chemical media. The development method used is ADDIE (Analysis, Design, Development, Implementation, Evaluation) which is modified by the researcher so that in this development research, only four stages are carried out, namely analysis, design, development and evaluation. The validation of the developed hydrocarbon chemical media was managed on a Likert scale of 1-4 by five expert validators, namely chemistry lecturers and teachers. The results of the analysis from the validation by expert validators on the feasibility of hydrocarbon chemical media according to the BSNP (National Education Standards Agency) modified with SETS eligibility are the content feasibility aspect of 3.58 (89.50 %); language feasibility aspect 3.68 (92.00%); presentation feasibility aspect 3.49 (87.25%); aspects of the feasibility of graphics 3.41 (85.25%); the feasibility aspect of implementing SETS 3.41 (85.25%). The average score of validation by the five validators is 3.54 with valid criteria and a presentation of 86.80% in a very feasible category. Based on the results of the validation of the hisrocarbon chemic media, it was concluded that the hydrocarbon chemical media was in accordance with the feasibility of the BSNP (National Education Standards Agency) modified with SETS eligibility and showed that the SETS-based hydrocarbon chemic media (chemistry comic) was very suitable to be used as a learning medium on hydrocarbon material.

1. Introduction

The world of education is always have several problems. According to the interview results between the researcher and one of chemistry teacher, information was obtained that a few students were not interested in learning chemistry because it was difficult to understand the chemistry subjects. This is due to many factors, one of them is chemistry material contains a lot of abstract and complex knowledge. This factor is the same as the expert opinion that the abstract learning makes students feel bored to learn (Speight, 2019). Research conducted by Orgill & Shuterland (2008) related to the characteristics of chemistry material includes submicroscopic representation. Submicroscopic representation is event that cannot be seen by the eye so that it is visualized through several relevant



descriptions so that it can be understood (Maratusholihah et al. 2017). Understanding the material and being enthusiastic to learn abstract and complex material can be pursued by using learning media. The lack of learning media use results in the learning process being boring for students (Pakpahan et al. 2021).

One of the efforts that can be done in overcoming the problems in learning chemistry is that researcher developed interesting and easy learning media for students to use. The researcher hopes through the development of relevant learning media, students will be more interested in exploring knowledge about hydrocarbon materials and the number of learning media will increase. For teachers, learning media can concrete concepts or ideas conveyed and help students to be able to learn actively (Karo & Rohani, 2018). Thus, in this research, one of the learning media was developed, namely the hydrocarbon chemistry comic (Chemic) media based on SETS (Science, Environment, Technology, Society).

Comics are an attractively designed graphic media that has a popular aesthetic value. Therefore, it is possible to modify the learning media on chemistry materials, especially on hydrocarbon material, which are packaged with comic designs that have the potential to improve science communication. The uniqueness of science comics media, especially in chemistry comics (Chemic), is the ability of comics to communicate various messages communicatively, easy to understand and interesting, and increase motivation in the teaching and learning process (Hakim, 2018).

Based on previous research conducted by Nisa et al. (2021) regarding the development of comic-based learning media on the reaction rate, it showed that student learning outcomes met the KKM and some even exceeded the KKM. The researcher concluded that students were very enthusiastic about using chemistry comic books in understanding reaction rates (Sari & Harahap, 2021; Nisa et al. 2022) and of course increasing student motivation and learning outcomes.

The SETS approach (Science, Environment, Technology, Society) is an approach in effective learning that is able to improve the application of science, think critically and improve literacy skills (Sari, 2019). Therefore, the author conveys the idea of developing learning media in the form of a SETS-based chemistry comic (Chemic) on hydrocarbon material of class XI IPA in odd semester.

The design and use of comics media can be relevant to various contexts of purpose, both in entertainment and science. Comic media can provide entertainment as an additional value for readers and comic media in education will increase learning outcomes and student curiosity motivation (Aswan, 2021). Some of the characteristics of comic are as follows: 1) Humorous, with the meaning that the use of language and its components is easily understood by readers generally; 2) Personal, the uniqueness of comic that is able to bring the reader's emotions into stories or writings and images in comic; 3) Contains moral behavior, the soul of the character which is described in a simple way so that it tends to be easily guessed by the reader; 4) Language that is not too formal, with the meaning that the language used in comic is everyday language that is easy to understand but must be precise and correct; 5) Interesting with supporting images of relevant story texts (Arulan, 2013).

The SETS approach is an approach that consists of four components, namely Science, Environment, Technology, Society. SETS starts with simple things to complex from the environment around students in science. The SETS approach aims to provide contextual learning, students are faced with situations to utilize technology for the benefit of society, and are asked to always be active and think critically about something that can be researched and linked in science and technology. (Atmojo, 2020).

SETS-based chemic media on hydrocarbon has a unique value or interest to read it specifically, namely hydrocarbon comic is designed with attractive and aesthetic pictures and hydrocarbon comic is developed based on SETS so that there is interesting knowledge about hydrocarbon in comic. The hydrocarbon material in the comic consists of science related to hydrocarbons, the role of

hydrocarbons in the environment, the use of technology in hydrocarbon, the introduction of important things to be known by the public regarding hydrocarbon (Speight, 2019).

The hydrocarbon material studied in the comics is adjusted to the 2013 curriculum. Hydrocarbon material in class XI IPA SMA includes several indicators that must be studied, namely: 1) The peculiarities of carbon atom. 2) Primary, secondary, tertiary, and quaternary carbon atoms. 3) Structure and nomenclature of alkanes, alkenes and alkynes. 4) Physical properties of alkanes, alkenes and alkynes. 5) Isomers. 6) Reaction of hydrocarbon compounds. 7) Petroleum fraction. 8) Hydrocarbon compounds in everyday life.

2. Method

This research was conducted at the Department of Chemistry, Faculty of Mathematics and Natural Sciences, University in Indonesia. The time of the research was carried out from September-November 2020. This research used a type of Research & Development with the ADDIE (Analysis, Design, Development, Implementation and Evaluation) model, which is a research method used to produce new products and then test the effectiveness and validity of the product (Silaen & Silaban, 2022; Mawaddah & Silaban, 2022). The development of interesting and innovative SETS-based chemic media on hydrocarbon with the ADDIE development stage can be seen in Figure 1. This research consisted of several validators to validate chemic media, namely 2 chemistry lecturers, 1 comic media expert lecturer, and 2 chemistry teachers.

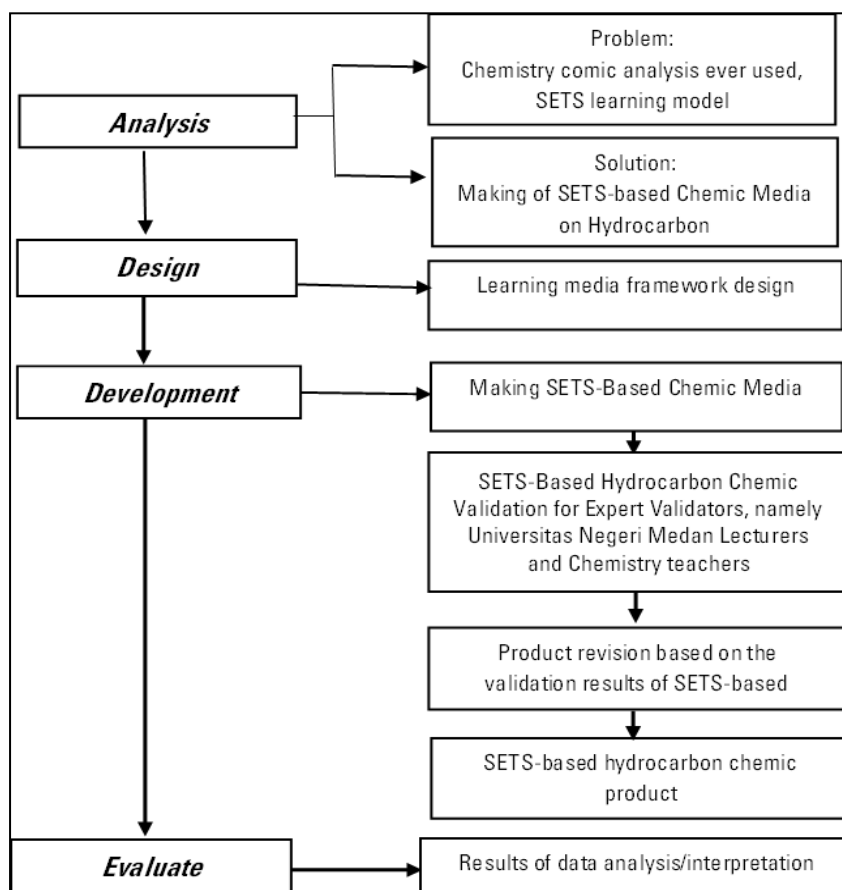


Figure1. Flowchart of Research & Development Procedure (modification of Manalu et al. 2016)

This research had gone through a validation process carried out by experts to determine the feasibility of developing this chemic media. To carry out the media validation stage, the researcher tested the media validation sheet according to the BSNP which was modified with the SETS

approach feasibility test in the developed chemic media. The validation sheet is prepared using a Likert scale in its assessment. The validity category can be seen in [Table 1](#).

Table 1. Validation Category ([Arikunto & Yuliana, 2008](#))

No	Answer Options	Score
1	Strongly Agree	4
2	Agree	3
3	Disagree	2
4	Strongly Disagree	1

To process the amount of the respondent's answer score obtained, the processing of the score (ΣS) of each answer to the question items in the questionnaire is as follows:

- 1) Score for statement Strongly Agree
Score = 4 x number of respondents who answered Strongly Agree
- 2) Score for statement Agree
Skor = 3 x number of respondents who answered Agree
- 3) Score for statement Disagree
Skor = 2 x number of respondents who answered Disagree
- 4) Score for statement Strongly Disagree
Skor = 1 x number of respondents who answered Strongly Disagree

Systematically, the following is the formula for calculating the percentage of feasibility assessment used to obtain the percentage category for the feasibility assessment of chemic media according to [Table 2](#).

$$\text{Percentage of eligibility scores} = \frac{\text{Score obtained}}{\text{Maximum score}} \times 100\%$$

Table 2. Percentage analysis validation criteria ([Arikunto & Yuliana, 2008](#))

Percentage (%)	Validity level	Description
100- 76	Valid	Eligible/no need to be revised
75- 51	Quite Valid	Quite eligible/partial revision
60- 26	Less Valid	Less eligible/partial revision
< 26	Invalid	Not eligible/total revision

3. Results and Discussion

3.1. Analysis Stage

The analysis stage in this research is a needs analysis activity which includes chemical materials, especially the subject of hydrocarbon, the characteristics of students, learning media obtained from the researcher's of interview results with one of chemistry teachers. Based on the interview results, the teacher said that many students considered chemistry, especially the subject of hydrocarbon, difficult to understand and students were less interested in to learn it. This happens because some students are difficult to understand abstract material and feel bored to learn chemistry. The researcher also conducted analysis to the results of the comic media development that had been developed by previous researcher, as shown in [Table 3](#). From the results of the analysis, several components were obtained that is not in accordance with the BSNP standards, such as compinents of content feasibility, language feasibility, presentation feasibility.

In the chemical comic on reaction rates material developed by [Harahap \(2020\)](#), the material study is incomplete, it is only explaining the application of reaction rates in everyday life, factors that affect

reaction rates, graphs of reaction rates, while the formula for calculating the reaction rates order and formula for calculating rates reaction under different condition do not exist. The theoretical study component does not provide a broad description of the reaction rate, so that in its use, this comic has not been used as the main source of learning. And some of the presentations are still inaccurate according to [Table 4](#). So, in developing this hydrocarbon chemic media, researcher will minimize the weaknesses of chemic media as shown in [Table 5](#). Researcher developep hydrocarbon chemic media according to the modified BSNP standard with the SETS approach.

Table 3. Product Analysis of Comic Media Development Based on Previous Researcher

Researcher Name	Research Title	Research result	Difference
Sari & Harahap (2021)	Development of Comic- Based Learning on Reaction Rate for Learning to be More Interesting and Improving Student's Learning Outcomes	The comic developed are very feasible to be used in the teaching and learning process of chemistry, especially on the subject of Reaction Rate. Student learning outcomes are achieved to meet the KKM and the average student learning outcomes are 81.07. The comic developed have been validated and the eligibility criteria results are 93.29% with very feasible descriptions.	Previous researcher developed PBL-based comic media on reaction rate materials, while current researcher developed SETS-based chemic media on hydrocarbon materials.

Table 4. Tabulation of reaction rate comic analysis results developed by [Harahap \(2020\)](#) based on BSNP standards.

Analyzed components	Description
Content Eligibility	<ul style="list-style-type: none"> a. The indicator for the reaction rate material has not been presented completely according to the 2013 curriculum syllabus b. Not present the topic of calculations and formulas completely c. Not present a detailed discussion of the problem d. Not present examples of reaction rates completely
Language Eligibility	<ul style="list-style-type: none"> a. Not present a glossary to equate the meaning of the terms used in the comics about reaction rates
Presentation Eligibility	<ul style="list-style-type: none"> a. Not use word box in conversation like typical comic generally b. Lack of use of punctuation c. Not use reading limits in comic so that the order of conversation sentences is less clear d. All the types of letters used are of the same type and the letters are not capslocked so that the conversational sentences look small

Based on the results of the needs analysis, the development of this chemic media is attempted to: (i) develop a good, interesting and entertaining storyline so that it has qualities that educate and inspire students, (ii) design unique comic characters from a visually relevant perspective, (iii) develop comic with educative content but still entertaining, and (iv) balance the applied learning strategies so that the learning targets according to the basic and core competencies according to the curriculum are expected to be achieved. Through the four components of the SETS approach to the development of hydrocarbon chemistry, it can make knowledge about hydrocarbons wider and motivate students to think critically.

3.2. Design Stage

This comic will be designed according to the storyline by taking the theme of hydrocarbons which is narrated in an interesting way. At the initial stage, the researcher first compiled the comic storyline, then the researcher began to carry out the stage of designing comic images. The design of the storyline was done to find out how the storyline of hydrocarbons chemically so that it becomes an interesting and easy-to-understand story. The plot used as the basis of reference is as in Table 6.

- i. The Main Character : Mr. Saleh, Ester, Meli
- ii. Theme : Hydrocarbon and its role in the four components of SETS
- iii. Story Direction : Fun learning with friends by thinking critically in the application of hydrocarbon in everyday life according to the SETS approach.

Table 5. The Chemic hydrocarbon component tabulation developed based on the modified BSNP standard according to the SETS approach.

Developed Aspect	Description
Content Eligibility	<ol style="list-style-type: none"> a. The theoretical review presented is eight indicators of hydrocarbon material according to the 2013 curriculum syllabus b. The contents of the hydrocarbon material are presented completely and detailly with the application of hydrocarbons in everyday life that are both classical and modern according to the development of science and technology c. Contents of hydrocarbon material is complete according to the four components of SETS d. Present examples of questions according to hydrocarbon material indicators and discussion of problems
Language Eligibility	<ol style="list-style-type: none"> a. The use of symbols is presented correctly b. The language is easy to understand and not too standard like everyday language generally
Presentation Eligibility	<ol style="list-style-type: none"> a. Glossary presentation b. Present relevant supporting pictures on the concept of hydrocarbon material c. The discussion of hydrocarbon material is presented coherently according to the order of indicators of hydrocarbon material in the 2013 curriculum syllabus d. Learning objectives are presented detailly

Table 6. Characteristics of the Main Characters of Hydrocarbon Chemic

No	Main Characters	Characteristics
1	Ester	Smart, class champion, likes to learn chemistry and think critically
2	Meli	Smart, Competitive to win the class
3	Mr. Saleh	Teachers who are loved and feared by students, smart and fun
4	Niko	Dislikes chemistry, daydreaming, cons of Esther
5	Sarah	Beautiful, loves all subjects, Reno's best friend

Chemic drawings or sketches were designed manually by drawing comic sketches on A4 paper and then making thick lines on the designed drawing with comic markers. After the image was thickened with twinpen, the comic sketch was deleted so that the resulting image was not shaded and will look more presentable with the IbisPaint X app. Then the finished sketch was scanned so that it can be able to insert words or dialogue into the comic book that will be created. Insertion of words or dialogue into comic was made using the help of MS Word. This comic will be made into a book-shaped media with a size of 15 x 21 cm. The physical appearance of each character had been

designed in a rough drawing as shown in Figure 2. After the dialogue text was made in the form of a word box, the comic was colored using the IbisPaint X application, as shown in Figure 3.

3.3. Development Stage

This stage includes the preparation of learning media in the form of chemis that will be developed. The activities of collecting materials, making illustrations, typing, etc. take place at this stage of development. Product design, and making instruments to measure product eligibility criteria. The conceptual framework that has been prepared at the design stage will be realized at the development stage into a product that is ready to be implemented after going through the validation stage from the expert validator. There are five validators used in this development, namely three lecturers and two teachers. Aspects that are assessed from chemis media are aspects of the content feasibility, aspects of language feasibility, aspects of presentation feasibility, aspects of graphic feasibility and aspects of feasibility of implementing the SETS approach in hydrocarbon chemis as a result of development.

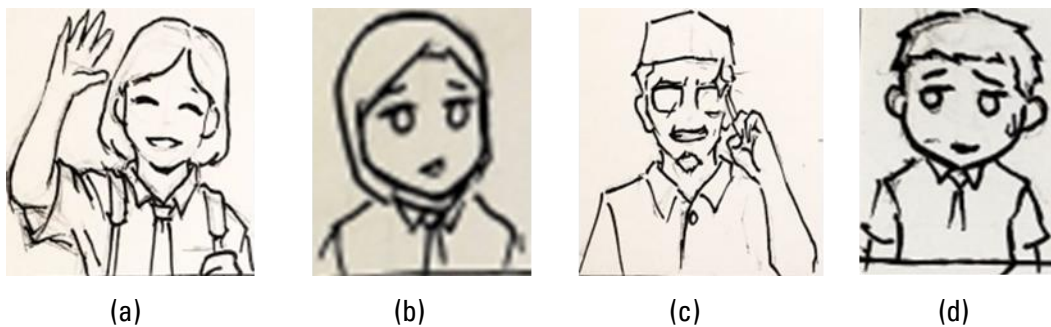


Figure 2. Hydrocarbon chemis main character: (a) Ester, (b) Meli, (c) Mr. Saleh, (d) Niko

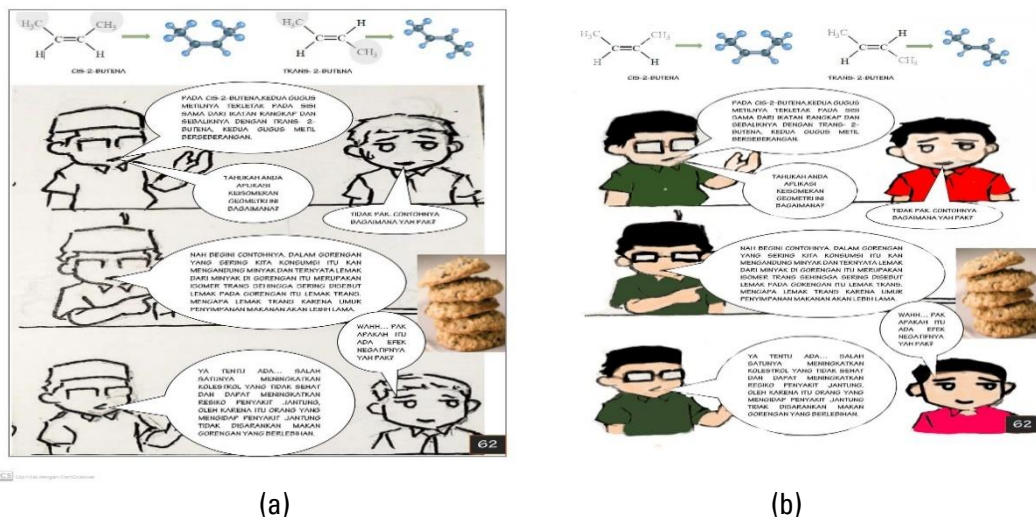


Figure 3. Chemis color design with IbisPaint X: (a) Before, and (b) After



Figure 4. Example elements of environment in Chemistry comic

The purpose of this media assessment is to determine the quality of the product to be suitable for use as a learning media. The assessment was carried out using an instrument in the form of a questionnaire. All of these data and services will be used as consideration for the improvement of hydrocarbon chemis learning media. Figure 4 shows the example elements of environment. Figure 5 Chemistry comic are developed with four elements SETS approaches, example elements of science: about science related to hydrocarbon; elements of environment: burning ice phenomenon (ice crystal methane hydrate) and tree termites emit methane, elements of technology: website of science and; society about: benefits of hydrocarbons in people's lives.

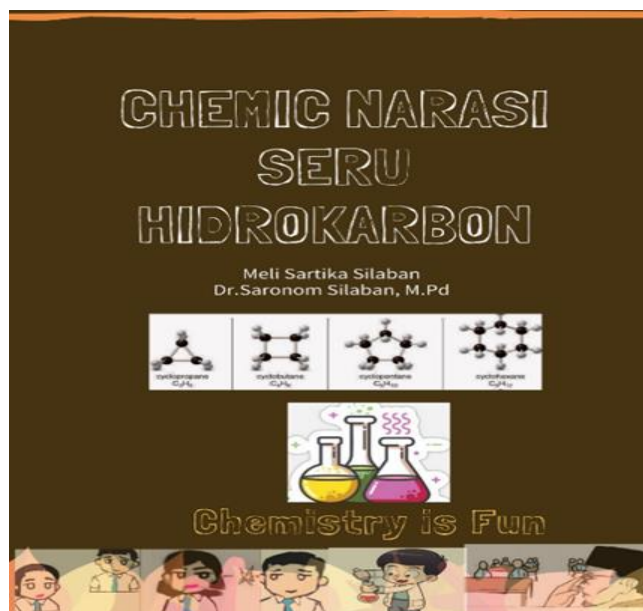


Figure 5. Cover Series

3.4. Evaluate Stage

Formative evaluation was carried out to collect data on each validation of the assessed chemical feasibility aspects. The validation results show that SETS-based hydrocarbon chemis learning media is valid and feasible to be used as learning media in schools. The results of the validation by 3 expert lecturers and 2 chemistry teachers are available in Table 7.

Table 7. Validator Validation Results

Indicator	Validator					Average	Criteria
	I	II	III	IV	V		
Content Eligibility	3.17	3.75	-	3.67	3.75	3.58	Valid
Language Eligibility	3.33	4.00	-	3.90	3.50	3.68	Valid
Presentation Eligibility	3.40	3.70	-	3.22	3.66	3.49	Valid
Graphic eligibility	2.96	3.78	3.15	3.87	3.31	3.41	Valid
SETS impelentation	3.43	3.42	-	3.85	3.43	3.53	Valid
Average	3.26	3.73	3.15	3.70	3.52	3.54	Valid
Percentage	81.50	93.25	78.75	92.50	88.00	86.80	Very high
$\frac{\text{Score obtained}}{\text{Maximum score}} \times 100$ %	%	%	%	%	%	%	

Based on the table above, it is known that the validation results from validator I with an average score of 3.26 (81.50%) indicate that it is feasible to be used as a learning media according to the feasibility validation category in table 7. The validation results from validator II with an average score 3.73 (93.25%) indicates that the chemis media is feasible to use. The validation results from validator

III with an average score of 3.15 (78.75%) indicate that the chemic media is quite feasible to use. The validation results from validator IV with an average score of 3.70 (92.50%) indicate that chemic media is feasible to use and the revised results of validator V show an average validation score of 3.52 (88.00%) so that it is feasible for use as learning media.

The assessments obtained from the five validators were based on the provision of a non-test questionnaire instrument according to the modified BSNP standard with the feasibility of SETS impelentation in the developed hydrocarbon chemic media. The results of the five validators with an average score of 3.54 (86.80%) indicate the criteria are feasible to use as a hydrocarbon learning medium.

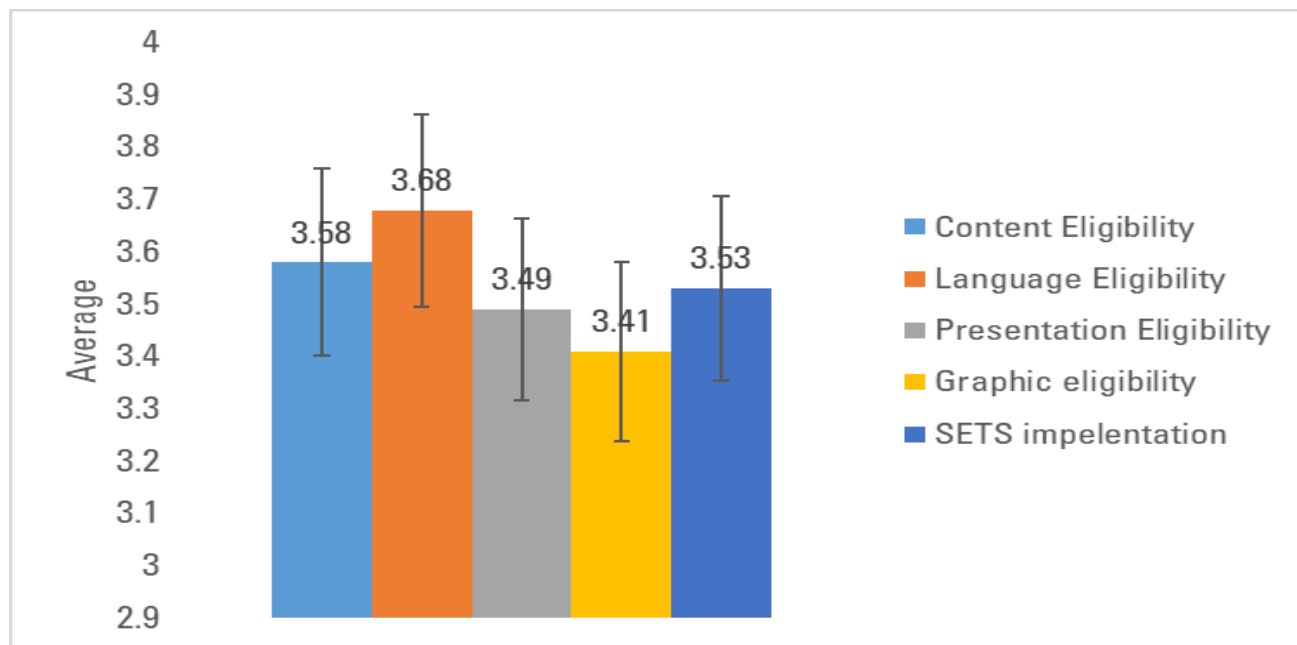


Figure 6. Graph of Average Validation Score Assessment Results

Figure 6, shows that the feasibility questionnaire according to the BSNP feasibility modification of SETS results from expert validator validation obtained a content feasibility aspect 3.58 (89.50%), language feasibility aspect 3.68 (92.00%), presentation feasibility aspect 3.49 (87.25%), graphic feasibility aspect 3.41 (85.25%), and SETS implementation aspect 3.53 (88.25%). With the average score of validation by the five validators is 3.54 (86.80%), it shows that the media is feasible to be used as a learning media in accordance with the positive assessment of the five validators and needs a little revision in order to get more media assessment results.



Figure 7. Design of Blank Space in the Comic Sheet (a) before, and (b) after

Some suggestions for improvement given by expert validators are as follows:

- i. The design and size are standard, maybe it could be better if it was compressed with a smaller paper size.
- ii. The font size is too monotonous and the same. We recommend that the font size used also varies, depending on the stress of delivering the character.
- iii. The size of the comic is proportional, but it should also be noted that there is a lot of free space in the comic sheet.
- iv. The presentation of concepts is easy to understand and the sequence is clear. It may need to be supplemented with material boundaries, or material subtitles so that readers know what concept is being explained.

After the chemical comic was evaluated, several revisions were made as follows in [Figure 7](#), [Figure 8](#) and [Figure 9](#).

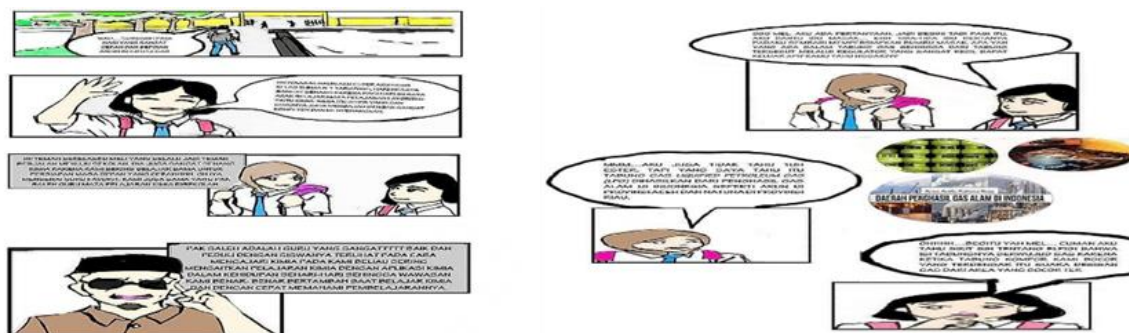


Figure 8. Design of Conversation Limit Space in the Comic Hydrocarbon Sheet.



Figure 9. Subtitle Material in the Comic Topic Boundary.

The chemic revision in Figure 6 is the result of the evaluation of the validator so that the presentation of the concept is easy to understand and the sequence is clear. So that at this revision stage it is necessary to include material boundaries, or material subtitles so that readers know the concept that is being explained. So that after the revision of the product in the form of hydrocarbon chemic media, the media is of maximum quality and is suitable for use in chemistry learning, especially on hydrocarbon materials (Chuang, 2014; Cantor et al. 2019). This hydrocarbon chemic media will be printed first with a proportional print size of A5 paper (15 X 21) cm. Then the author will take care of the copyright of the hydrocarbon chemic media so that it can be distributed and become one of the hydrocarbon learning media that is valid and feasible for use with the recognition of the ISBN (International Standard Book Number).

4. Conclusion

Based on the results of the research, it can be concluded that the modified hydrocarbon chemic learning media with SETS feasibility shows that SETS-based hydrocarbon chemic media is feasible to use according to the score of a content feasibility aspect 3.58 (89.50 %), language feasibility aspect 3.68 (92.00%), presentation feasibility aspect 3.49 (87.25%), graphic feasibility aspect 3.41 (85.25%), and SETS implementation aspect 3.53 (88.25%). With the average score of validation by the five validators is 3.54 (86.80%), category very high indicating that the media is feasible to be used as a learning media.

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