Development of e-Comic Science Interactive Learning with Scratch (eCILS) Based on Problem Based Learning to Train Critical Thinking Skills for Junior High School Students

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Abstract

This study aims to develop e-comic science interactive learning with scratch (eCILS), to analyze eCILS' characteristics, test eCILS' validity, and determine user responses. The research method is development research. The research procedure used is 4D (defined, designed, developed, and disseminated). The research was only up to development due to the pandemic. The result of this research is eCILS. ECILS is an e-comic learning media that have characteristics: (a) equipped with a bibliography, (b) in accordance with problem-based learning syntax, (c) could train critical thinking skills, (d) stories that are displayed in accordance with everyday life, (e) equipped with instructions to use, and (f) in accordance with the characteristics of interactive media learning. ECILS media is very valid to use, this is based on the assessment of material validators who get an average score of 95.63% and media validators 94.38%. Response students to the media are very good indicated by the results of the questionnaire responses of students who get an average of 82.15%. Based on this, it can be concluded that eCILS media can be used as a medium to train critical thinking skills.

How to Cite

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INTRODUCTION

Republik Indonesia's Law Number 20 of 2033 concerning the "National Education System" Chapter 1 Paragraph 1 states that learning is a process of interaction between students, educators, and learning resources in a learning environment. The learning process needs to be supported by adequate facilities and infrastructure. The facilities and infrastructure are in the form of learning components, one of which is learning media (Putra, 2013). Learning media are tools used in teaching and learning activities, to convey learning information from teachers to students (Tim Pusdiklat Pegawai Kemendikbud, 2016). Learning media has a positive impact on students' reading abilities (Untari & Saputra, 2016). However, according to the Program for International Student Assessment (PISA) survey conducted by the Organization for Economic Co-operation and Development in 2018, it was stated that the reading ability of Indonesian students was still low. The average reading ability score of Indonesian students is 370.5 while the overall reading ability score is 487 (OECD, 2018).

Reading ability affects students' critical thinking skills because reading is a means to develop critical thinking skills (Pangestuti et al., 2014). Critical thinking skills are very important to be developed so that students can solve problems in the real world (Rossana et al., 2019).Critical thinking skills can be trained using learning media because learning media can stimulate reading skills. However, the use and utilization of learning media are still not optimal. Hikmawati & Jufri (2020) state that the learning media used in science learning are still lacking and not optimal so that it affects student learning outcomes. The results of observations at SMP N 3 Blora that the learning media that are often used when online learning, are videos and power points. When online learning, the teacher cannot observe the abilities possessed by students, one of which is the ability to think critically. The teacher does not know for sure how the student's critical thinking skills are. To prevent the decline in students' critical thinking skills, media that contains aspects of critical thinking skills is needed. The use of learning media that contains aspects of critical thinking skills can train students' critical thinking skills. Therefore, it is necessary to develop learning media. Develop learning media that is integrated with learning models that can train critical thinking skills and include aspects of critical thinking skills. The learning model that can train critical thinking skills is Problem Based Learning (PBL).

Suratno et al. (2020) state that Problem Based Learning has a positive effect on students' critical thinking skills. Learning media that is suitable for integrating problem-based is a comic. Comic is an interesting medium because it contains colorful illustrations, concise storylines, and realistic personality traits that will attract students of various ages (Lestari & Projosantoso, 2016)(2. The media is presented as online comics or e-comic. E-comic can be created with scratch software. Scratch supports the creation of interactive media. McManus (2013) explains that Scratch is the perfect programming tool for creating games, interactive stories, and other visually rich programs. This media was then called the e-Comic Science Interactive Learning with Scratch (eCILS) media based on Problem Based Learning (PBL) to train the critical thinking skills of junior high school students.

The aims of this research are: (1) to develop e-Comic Science Interactive Learning with Scratch (eCILS) learning media based on Problem Based Learning (PBL), (2) to analyze eCILS' characteristics, (3) to test eCILS' validity, and (4) knowing the students' responses to eCILS media.

METHOD

The subjects of this study were material validators, media validators, and 32 students of class VIII SMP N 3 Blora. The research method is development research. The procedure research is a 4D model (define, design, develop, and disseminate) which was developed by Thiagarajan (1974). In this study, dissemination was not carried out because of a pandemic. The development step was carried out to obtain media readability data and student response data.

Data Collection Technique

The data collection techniques used are (1) interview method used to determine the learning media that is often used, (2) documentation method to determine the subject of research and documentation, and (3) questionnaire method used to assess the media by validators and student responses. The questionnaires and research instruments used in this study were: (1) media validation questionnaires, (2) media readability questionnaires, and (3) media usage response questionnaires. The research questionnaire uses a 4-scale Likert scale. The data analysis in this study are (1) analysis of media characteristics, (2) analysis of media validity, and (3) analysis of media use responses. Analysis of characteristics,

validity, and response of the media using the formula:

$$P = f/N \times 100\%$$

(Arikunto, 2006).
with,
P: percentage
f: number of scores
N: maximum number of scores.
Characteristics media criteria can be seen in table 1.

Table 1. Characteristics media criteria

Score (%)	Criteria
$81{,}25 < score \leq 100{,}00$	Very Good
$62{,}50 < score \leq 81{,}25$	Good
$43{,}75 < score \leq 62{,}50$	Not Good
$25{,}00 < score \leq 43{,}75$	Not Very Good

The characteristic of the eCILS media is good if the score is more than 62,50%. Respons to media criteria can be seen in table 2.

Table 2. Respons to media criteria

Score (%)	Criteria
$81{,}25 < score \leq 100{,}00$	Very Good
$62{,}50 < score \leq 81{,}25$	Good
$43{,}75 < score \leq 62{,}50$	Not Good
$25{,}00 < score \leq 43{,}75$	Not Very Good

Respons good if the score is more than 62,50%. Validity media criteria can be seen in table 3.

Table 3. Validity media criteria

Score (%)	Criteria
$81{,}25 < score \leq 100{,}00$	Very Valid
$62{,}50 < score \leq 81{,}25$	Valid
$43{,}75 < score \leq 62{,}50$	Not Valid
$25{,}00 < score \leq 43{,}75$	Not Very Valid

ECILS is valid if the score is > 62,50%.

RESULT AND DISCUSSION

E-Comic Science Interactive Learning with Sctarch (eCILS) Based on Problem Based Learning

The media development step is defining, designing, and developing. The define step shows that the learning media that are often used in SMPN 3 Blora are videos and power points. After getting the data media that is often used, it is continued with material analysis. Material analysis was carried out by discussion with science teachers and studying literature. The materials used in

the media are additives and addictive substances. The next activity is the determination of learning indicators which are carried out by adjusting them to basic competencies. The design step is carried out by analyzing the developed media, learning models, determining aspects of critical thinking skills, and designing eCILS media. Media analyzed by studying literature on applications that are rarely used in education. The application is scratch. Scratch supports the creation of animated and comic media. The results of the literature study encouraged the development of eCILS media. Furthermore, an analysis of the learning model will be integrated into the media. The analysis was carried out by a literature study. The results of the literature study show that comics can be integrated with problem based learning models to train critical thinking skills.

Aspects of critical thinking skills are obtained by studying literature. Ennis (2013) explains that aspects of critical thinking skills include: (1) providing simple explanations, (2) building basic skills, (3) concluding, (4) providing further explanations, and (5) strategies and tactics. After that, the media design was carried out. Media design includes characters who play a role in comics, comic storylines, comic backgrounds, and making media assessment instruments. The data development step is (1) eCILS media, (2) media validation results, (3) suggestions from validators, and (4) student response data.

Media e-Comic Science Interactive Learning with Scratch (eCILS) based on Problem Based Learning has been developed. eCILS media are provided with instructions for use and descriptions of the functions of the buttons in the media. The menu displayed on eCILS media is shown in Figure 1.
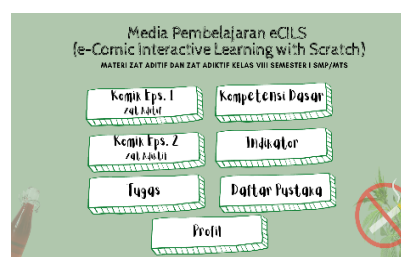

Figure 1. Menu display on eCILS

Figure 1 is the main menu display on eCILS. The main menu contains basic competencies, learning indicators, episode one (additive material), episode two (addictive material), assignments, bibliography, and developer profile. eCILS media contains basic competencies 3.6 and 4.6. Basic competence 3.6 is to explain various additives

in food and beverages, addictive substances, and their impact on health. Basic competence 4.6 is to write a paper on the misuse of additives and addictive substances for health (Kemendikbud, 2017). Prasetyo et al. (2019) explain that the learning media created must be in accordance with the age of the students and the basic competencies in the 2013 curriculum.

ECILS media contains learning indicators that will be achieved by students. Arsyad (2013) states that one of the criteria for good learning media is according to learning indicators. ECILS contains additives and addictive substances. Additive material is available in episode one comics and addictive material is available in episode two comics. The preparation of stories in comics is adjusted to the learning indicators so that they are interconnected. Fahyuni & Fauji (2017) explain that storylines in comics must be interconnected. The content of the story in the comic uses examples of material in everyday life and material that students rarely encounter. The appearance of these materials is intended to support learning. Otoluwa et al. (2019) explain that media must support learning activities. The comic is integrated into the problem-based learning syntax so that it can train students' critical thinking skills. Hida (2020) explains that comic science based on problem-based learning can improve students' critical thinking skills. Assignments in eCILS media contain essay questions and assignments to write a paper. Questions are made with aspects of critical thinking skills in order to train students' critical thinking skills. Yunita et al. (2018) stated that students' critical thinking skills were stated in the medium category when answering the essay questions. ECILS comes with a bibliography and developer profile.

The development process is carried out by applying the suggestions from the validator. Suggestions from the material validator are: (1) re-examined there are still typo writings, (2) clarify the concept of additives, (3) basic competence 4.6 has not been seen, nor has it appeared in indicators, (4) clarify the concept of artificial sweeteners, (5) added some important Figures, and (6) questions placed on the media. Suggestions from the media validator are: (1) the background display can be added, (2) fix the pause each conversation, (3) add pause button, (4) differentiate the answers, and (5) development is also carried out for children with special needs. The material validator gives suggestions to be re-examined because there are still some typo words. Then in the dialogue, addictive substances or food additives are changed to additives or called food additives.

This is to avoid misconceptions among students. One of the causes of misconceptions in students is the wrong perception of language. The language perception in question is that students cannot interpret the meaning of the sentences displayed (Fatmasari, 2021). The material validator provides suggestions for showing basic competencies 4.6. Basic competencies 4.6 on the media loaded on the task menu. One of the steps in making learning media is to determine the learning objectives to be achieved (Ulfah, 2020). The next suggestion is for clarity an additive concept and an additional explanation on sweetener content. This suggestion is following the opinion of Asyhari & Silvia (2016) which states that material in the media should be in accordance with the concept of science correctly and not violate the concept. The material validator suggests to add supporting images. The addition of supporting images in eCILS helps students to understand the material. This suggestion is following Widjayanti et al. (2018) that states the use of learning media can make it easier for students to understand the material. The material validator also provides suggestions that the questions should be placed on the media. This is more considered practical than presented in printed form. One of the indicators of media assessment is practicality (Putri & Riwayati, 2021). The practicality of the media can motivate students to learn.

The media validator suggests adding backgrounds. The use of the background in comics can be adjusted to the appearance presented (Amini & Damayanti, 2021). The media validator suggests that the conversation breaks are adjusted to the children's reading speed and do not pile up on each other. Breaks on eCILS is fixed according to the validator's suggestions, so conversations don't overlap and in long conversations, they look longer. The media validator suggests to differentiate answers on conversations. This suggestion has been implemented so that if the user chooses an answer, an explanation will appear according to his choice. Next suggestion is to adding pause button. Scratch does not provide coding for the pause button, so it is replaced with the continue button. That development should also be carried out for children with special needs. This suggestion was not implemented because it was not in accordance with the research objectives.

Characteristics of eCILS

The characteristics of eCILS media were obtained from validator assessments and student readability questionnaires. The characteristics of eCILS media can be seen in table 4.

Table 4. Characteristics of eCILS media based on validator assessment and student assessment.

Characteristics	Validator assessment		Student assessment	
	Achievement (%)	Criteria	Achievement (%)	Criteria
ECILS is an e-comic learning media that completes information with bibliographies.	100,00	Very good	82,03	Very good
ECILS is an e-comic learning media that compatible with PBL syntax.	95,00	Very good	82,03	Very good
ECILS is an e-comic learning media that can train critical thinking skills.	90,00	Very good	82,03	Very good
ECILS is an e-comic learning media that the stories according to everyday life	100,00	Very good	85,16	Very good
ECILS is an e-comic learning media that completes with instructions for use.	100,00	Very good	82,03	Very good
ECILS is an e-comic learning media that conforms with the characteristics of interactive learning media.	95,00	Very good	82,81	Very good

Table 5. Validation of eCILS material aspect

Indicators	Achievement (%)	Criteria
Accuracy with basic competencies.	100,00	Very Valid
Accuracy with basic learning indicators.	100,00	Very Valid
The material is in accordance with facts, principles, and concepts.	90,00	Very Valid
The storyline of the delivery of the material.	90,00	Very Valid
Complete information with bibliographies.	100,00	Very Valid
Compatibility with problem based learning syntax.	95,00	Very Valid
Compatibility with critical thinking aspects.	90,00	Very Valid
Stories according to everyday life	100,00	Very Valid

Table 4 shows the characteristics of eCILS media. These characteristics are obtained from the assessment of validators and students. The average score of the assessment of media characteristics is 96,67% of the validator and 82,68% of the student's assessment. The average achievement of these characteristics is very good.

ECILS Validation

ECILS validation was obtained from material and media validators. The results of the eCILS validation of the material aspects can be seen in table 5.

Table 5 shows the results of the eCILS validation material aspect. All eCILS media assessment indicators are declared valid by material validator. The average assessment of material validators is 95,63% with very valid criteria.

The results of the assessment of the material and media validators agreed that the eCILS media was valid to be used. Validators give suggestions to eCILS. These suggestions are used to improve the media before testing the product.

Aripin & Suryaningsih (2019) stated that media should be validated before testing. ECILS media according to basic competencies. This is evidenced by the validator's assessment is 100,00% with very valid criteria. Arsyad (2013) stated that learning media must be developed to meet the objectives to be achieved. ECILS according to the learning indicators. This is evidenced by the validator's assessment is 100,00% with very valid criteria. Mahnun (2012) stated that not all learning media are used for all learning purposes, so development media must be adapted to learning objectives. The material on eCILS is in accordance with facts, principles, and concepts. This is evidenced by the validator's assessment is 90,00% with very valid criteria. Miftah (2013) states that learning media should display the truth of the material. The material validator provides that the content of the meaning of additives is more emphasized and the addition of explanations on artificial sweeteners. The advice given by the validator is in accordance with the opinion of Asyhari & Silvia (2016) which states that the presentation

of material in the media should be in accordance with the concept of science correctly and not violate the concept of science. Pratama et al. (2021) states that students are prone to misconceptions so that a learning tool is needed that can remediate students' misconceptions. Storyline of material delivery following the learning indicators. This is evidenced by the validator's assessment is 90,00% with very valid criteria. The purpose of adjusting the storyline with learning indicators is to make it easier for students to understand the material. The learning indicators make papers on the impact of substance abuse and addictive substances on health are not included in the story but included in the assignment. Widyawati & Prodjosantoso (2015) stated that comic is a medium that is easy to understand because it is packaged in a storyline. ECILS is equipped with a bibliography. This is evidenced by the validator's assessment is 100,00% with very valid criteria. Bibliography intended students can open it and read it so they can practice critical thinking skills. The habits of students in reading will have a positive effect on critical thinking skills (Fitrianti et al., 2021).

ECILS is following problem based learning syntax. This is evidenced by the validator's assessment is 95,00% with very valid criteria. ECILS show problems. The problem is the use of artificial additives and addictive substances that will cause health problems and even death. Giving problems to students can have a positive effect on critical thinking skills (Warahmah et al., 2021). ECILS can train critical thinking skills. The material and questions on the eCILS media are following the aspects of critical thinking skills. This is evidenced by the validator's assessment is 90,00% with very valid criteria. The suitability of eCILS media with aspects of critical thinking skills can train students' critical thinking skills. The material provided in the form of problems can have a positive effect on critical thinking skills. Astuti et al. (2018) state that students' critical thinking skills can be trained by finding solutions to the problems given. Questions on the task menu. Questions are given in essay form. Khairat et al. (2021) explain that the provision of essay questions that are integrated with aspects of critical thinking skills has a positive influence on critical thinking skills. Stories are displayed following everyday life. This is evidenced by the validator's assessment is 100,00% with very valid criteria. The story on additive material begins with the use of artificial coloring in drinks. This is often found in everyday life, especially in packaged foods or beverages. The story on addictive substances begins with the use of drugs by public figures. This is also often encountered by students, especially if they often see news through social media. The appearance of stories that follow everyday life aims to create contextual media. Wicaksono et al. (2017) stated that the development of contextual comic media needs to be developed because the existing science learning media are not yet tied to everyday life. The results of the eCILS validation of the media aspects can be seen in table 6.

Table 6 shows the results of validation eCILS media aspects. All media assessment indicators are declared valid by media validators. The average assessment of media validators is 94,38% with very valid criteria,

ECILS can be used repeatedly. This is evidenced by the validator's assessment is 100,00% with very valid criteria. Setiawati et al. (2019)so students need to learn resources that can facilitate them in receiving the material. Therefore, it is important to provide learning media as a learning resource to facilitate students to receive material, attract their attention and motivate students to learn. However, based on the previous study in SD Negeri Pahlawan, the use of learning media as a learning resource is still less than optimal, as well as the availability of social science learning media has not been widely developed, it is still a characteristic of social science such as maps, globe, and photographs of heroes which is displayed. Based on the explanation, this study

Table 6. Validation of eCILS media aspect

Indicators	Achievment (%)	Criteria
Can be used repeatedly.	100,00	Very Valid
Completeness of learning media with instructions for use.	100,00	Very Valid
Media as needed.	90,00	Very Valid
Readability of writing with appropriate font type and size.	90,00	Very Valid
Attractive and practical.	90,00	Very Valid
Conformity with the characteristics of interactive learning media.	95,00	Very Valid
The media is easy to use and simple in operation.	95,00	Very Valid
Use the appropriate language.	95,00	Very Valid

aims to develop learning media on the subject of the history of Islamic empires in Indonesia in the form of board game media. The purpose of this study is to describe the identification of initial needs of social science learning media development in class V Elementary School, to describe game board game design, to describe the implementation of game board media and to describe the final product of board game media. This research product is useful for teaching and learning activities in school. The research method used is Design Based Research (DBR explain that learning media must be durable and can be used repeatedly so that it is more useful in the long term. ECILS is equipped with instructions to use. This is evidenced by the validator's assessment is 100,00% with very valid criteria. Instructions to use are available in printed form and directly on scratch. Instructions for use on eCILS will help users to operate it. In addition to the instructions for use, eCILS media is also equipped with key functions on the media. The function keys in the media contain the key functions found on the eCILS. One of the eligibility criteria for learning media is that there are instructions to use (Sholihannisa & Juliawati, 2021). Instructions to use are also following one of the characteristics of interactive learning media, which is independent. Being independent means providing convenience and completeness of content so that users can use it without having to be guided by others (Kemendikbud, 2020). ECILS as needed. This is evidenced by the validator's assessment is 90,00% with very valid criteria. Nurrita (2018) explains that learning media developed according to the needs of students can help students concentrate on learning. The writing in the media according to the type and size of the letters. This is evidenced by the validator's assessment is 90,00% with very valid criteria. Ashyar (2012) explains that it is necessary to do effective writing on the media so that the message conveyed is easily accepted by readers. ECILS is attractive and practical to use. This is evidenced by the validator's assessment is 90,00% with very valid criteria. This is in line with the opinion of Nurseto, (2012) that one of the principles of learning media is interesting. Arsyad (2013) also explained that the learning media used should be practical.

ECILS according to the characteristics of interactive learning media. This is evidenced by the validator's assessment is 95,00% with very valid criteria. ECILS combines visual elements with audio elements. When a user clicks on a comic episode one or two, audio and image will appear. The audio is an introduction to pay attention to the media well. The images displayed on the eCILS are figures and Figures that support the material. The validator provides suggestions for adding important images such as pandan leaves, sugar, turmeric, etc. This suggestion is in line with one of the characteristics of interactive learning media, combining visuals and audio elements. ECILS is interactive. ECILS can provide the response requested by the user. The response is when the user clicks the desired button, the contents of the button will appear. Instructions to use on eCILS can make the user easier to operate it. This is in line with one of the characteristics of interactive learning media, which is independent. ECILS is easy to use and simple to operate. This is evidenced by the validator's assessment is 95,00% with very valid criteria. Nurseto (2012) explains that one of the principles of learning media is simple. The language used on ECILS is appropriate. This is evidenced by the validator's assessment is 95,00% with very valid criteria. Ashyar (2012) states that the use of language in the media must be in accordance with the rules of the language so that the material presented is easy to understand and there are no multiple interpretations.

Respons of eCILS

Student responses to the media can be seen in table 7. Table 7 contains the achievement of student responses to eCILS media. The average achievement obtained is 82.15% in the very good category. The students looked very enthusiastic when using eCILS media. E-comic made using scratch is a new medium for students so they are interested in using it. Anggreini & Dewi (2020) explained that students were very interested in learning media that they had just met. The language and storyline on eCILS are easily understood by students so that it does not cause misinterpretation. ECILS displays examples from everyday life. Giving this example makes it easier for students to understand the material. This is also supported by the opinion of students, namely the eCILS media contains materials that are easy to understand and make them understand about additives and addictive substances. Students stated that the eCILS media contained solvable problems. Students stated that the eCILS media is easy to use. This convenience is because students can access it anywhere and how to access it simply by clicking on the link provided. Although the eCILS media received a very good average response, there were also statements that received good responses from students. This statement is a blend of colors in harmonious eCILS media,

Table 7. Results of Student Response Achievements to eCILS

Statements	Achievement (%)	Criteria
ECILS design is interesting.	82,03	Very Good
The images and the size of the images contained on eCILS are compatible.	82,81	Very Good
The color combination on eCLIS is harmonious.	81,25	Good
The language used on eCILS is easy to understand.	84,38	Very Good
The storyline on eCILS is easy to follow.	82,81	Very Good
ECILS uses examples found in everyday life.	83,59	Very Good
ECILS contains a problem that can be solved.	82,03	Very Good
ECILS media can train critical thinking skills.	79,69	Good
ECILS can be used as interactive learning media.	79,69	Good
ECILS interests me to learn.	79,69	Good
ECILS made me understand the material of additives and addictive substances.	84,38	Very Good
The material on eCILS is easy to understand.	82,03	Very Good
ECILS is easy to use.	83,59	Very Good

eCILS media can train critical thinking skills, media can be used as interactive learning media, and eCILS media attracts students' interest in learning.

CONCLUSION

E-Comic Science Interactive Learning with Scratch (eCILS) Media based on Problem Based Learning (PBL) has been developed. ECILS is an e-comic learning media that have characteristics: (a) equipped with a bibliography, (b) in accordance with problem-based learning syntax, (c) a can train critical thinking skills, (d) stories that are displayed in accordance with everyday life, (e) equipped with instructions to use, and (f) following the characteristics of interactive media learning. ECILS media is very valid to use, this is based on the assessment of material validators who get an average score of 95,63% and media validators 94,38%. Response students to the media are very good indicated by the results of the questionnaire responses of students who get an average of 82.15%. Suggestions from this research are if we want to use this media, we should also be accompanied by other reference books, prepare stationery, and a stable internet connection.

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