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Penulis : Nur Khoiri, Diana Arin Wahyuningsih dan Duwi Nuvitalia

No.	Perihal	Tanggal
1	Bukti Abstrak yang di Upload	9 Agustus 2021
2	Bukti Konfirmasi Accepted Abstrac dan Penerimaan LoA	11 September 2021
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1. **Bukti Abstrak yang Di Upload (9 Agustus 2021)**

1 **DEVELOPMENT OF PHYSICS LEARNING MEDIA FOR SMA/MA CLASS X EVEN**
2 **SEMESTER ORIENTED CRITICAL THINKING SKILLS**

3

4

Abstract

5 Research has been carried out on the development of physics learning media which aims to
6 determine the impact on students' critical thinking skills. The research was carried out using
7 research and development methods which included identification, information gathering, product
8 design, product validation and product revision. Data collection was carried out using
9 questionnaires and tests. The results showed that the product development media was valid,
10 feasible and effective in improving students' critical thinking skills. The percentage of validity
11 scores is 77%. The percentage score is 78%. The results of statistical analysis show that the
12 developed learning media can improve students' critical thinking skills.

13 Keywords: Physics and Critical Thinking Skill


2. Bukti Konfirmasi Accepted
Abstrac dan Penerimaan LoA (11
September 2021)

10th ICMSE 2021 (index.php)

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2021 ▾

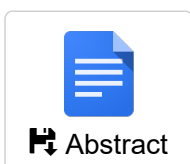
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Developing Learning Media of Physics Oriented by Critical Thinking Skills

Nur Khoiri, Duwi nuvitalia, Diana Arin Wahyuningsih
Upgris

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LETTER OF ACCEPTANCE

Dear Mr/Ms. Nur Khoiri

Paper Number : SE-2205

Paper Received : 09 Aug 2021

Paper Accepted : 11 September 2021

Paper Title : DEVELOPMENT OF PHYSICS LEARNING MEDIA FOR SMA/MA CLASS X EVEN SEMESTER ORIENTED CRITICAL THINKING SKILLS

Authors : Nur Khoiri, Duwi nuvitalia, Diana Arin Wahyuningsih

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We are pleased to inform that your abstract has been **accepted as ORAL PRESENTATION** at the 8th ICMSE 2021 which be held in October 5-6, 2021 at Virtual Conference (online) .

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Chairman of 8th ICMSE 2021

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dan Artikel yang di Kirim (19
September 2021)**



nurkhoiri upgris <nurkhoiri@upgris.ac.id>

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8th ICMSE 2021 <icmse@mail.unnes.ac.id>

19 September 2021 pukul 17.07

Balas Ke: no-reply@icmseunnes.com

Kepada: nurkhoiri@upgris.ac.id

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INTERNATIONAL CONFERENCE ON
MATHEMATICS, SCIENCE, AND EDUCATION

8th International International Conference on Mathematics, Science, and Education

Information | Fullpaper

Dear Mr/Ms. Nur Khoiri,

We have received your full paper and it is under reviewed.

Title : DEVELOPMENT OF PHYSICS LEARNING MEDIA FOR SMA/MA CLASS X EVEN
SEMESTER ORIENTED CRITICAL THINKING SKILLS

Author(s) : Nur Khoiri, Duwi nuvitalia, Diana Arin Wahyuningsih

Affiliation : Upgris

Scope : Science Education

Best regard,
8th ICMSE 2021 Committee

1 Developing Learning Media of Physics Oriented by Critical 2 Thinking Skills 3

4 Nur Khoiri^{1 a)}, Diana Arin Wahyuningsih², and Duwi Nuvitalia³

5 ^{1,2,3}Universitas PGRI Semarang

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8
9 **Abstract.** The research was carried out using the Research and Development method which includes define, design,
10 develop, and dissemination. The data was collected using a questionnaire, the observation sheets and the tests. The
11 results showed that the product development media is valid, feasible and effective in improving students' critical
12 thinking skills. The percentage of validity score is 77% and the percentage score is 78%. The results of statistical
13 analysis show that the developed learning media can improve students' critical thinking skills.

14 INTRODUCTION

15 The development of technology have had an impact on changes in various dimensions of human life, such as
16 economic, social, cultural and educational. These changes result in a movement towards a balance of the new life
17 order [1]. The challenge of a new life which is known as the 21st century requires the new types of skill. As a result
18 of the demands for change also have an impact on learning orientation which has shifted as a result of changes in
19 the new life order [2]. The skills needs of the current generation include critical thinking skills. Critical thinking skills
20 are strongly suspected to be very important skills needed by the current generation [3]. One of those affected by this
21 condition are the Teacher Trainer Institution (TTI) graduates or prospective teachers, since they teach the new
22 generation in different ways from the knowledge provided to prospective teachers when they studied at TTI [4].

23 One of the challenges that require continuous innovation for prospective teachers is related to the learning media
24 that will be used in the learning process [5]. Learning media is the tools that can be used to deliver the messages
25 from the learning materials which are expected to stimulate attention and interest. Android-based learning media
26 becomes one of the media in learning science that can be concreted by utilizing technological developments in the
27 field of education. Android is a very complete platform in which of its operating system, applications and
28 development tools. It has extremely high support from the open source community in the world; therefore, android
29 continues to grow rapidly in terms of technology and the number of devices in the world [6]. Moreover, android is
30 currently used by almost all school-age children, especially since the Covid-19 pandemic era. The use of Android
31 has been accelerated as a means of online school. Therefore, it is a significant need to optimize the use of learning
32 media through mobile learning by equipping the students with the particular skills which prepare them facing the
33 education in 21st century [7].

34 According to the TIMSS (Trends in International Mathematics and Science Study) 2015, the average percentage
35 of Indonesian students' reasoning abilities was 26%, while the international average was 44%. According to Bloom's
36 taxonomy, reasoning abilities are included in higher order thinking skills [8]. Critical thinking skills becomes a part
37 of higher order thinking skills that important to acquire. However, regarding to the condition of the low critical
38 thinking skills of students, it becomes a challenge and anxiety for educators in Indonesia to improve students' critical
39 thinking skills as future generations. Therefore, it is important to do a research in developing learning media of
40 physic which enable the teachers to create a conducive classroom so that increase the students' critical thinking skill.

41
42

METHODS

43 This study involves the Research & Development model, which is a process carried out to develop and validate
44 the educational products [9]. The data collection techniques are questionnaires and tests. The development
45 research consists of four stages, namely define, design, develop and disseminate [10]. Define is a preliminary
46 activity that aims to collect all the information needed through field studies and literature to compile the initial
47 product. There are two activities in this stage namely a literature study which consist of material analysis and
48 media making devices, and the second activity is that the use of media that was developed. The material that
49 delivered in the media should appropriate to the standard competence (SK) and basic competence (KD). The
50 assessment process which includes SK/KD analysis, learning resources, material selection and user determination
51 is carried out simultaneously because it is interrelated and cannot stand alone. At this stage, data collection is
52 also carried out that is closely related to the material, media making devices and the use of media. *Design* is the
53 activity of making detailed specifications of the media to be made. A good and well-planned design will make it
54 easier to create further media. The media design was firstly designed in the form of a script then developed
55 which consists of objects that will be used in making learning media such as text, images and sound using the MIT
56 App Inventor software. *Develop* is an activity to develop a product in the form of an Android application that
57 contains materials, exercises and evaluations related to learning materials and critical thinking skills such that
58 resulting a product that is ready to be validated. At this stage, the validation of the learning media used the MIT
59 App Inventor. This validation consists of material, media and user. *Dissemination* is an activity to disseminate
60 products to students.

61

RESULTS AND DISCUSSION

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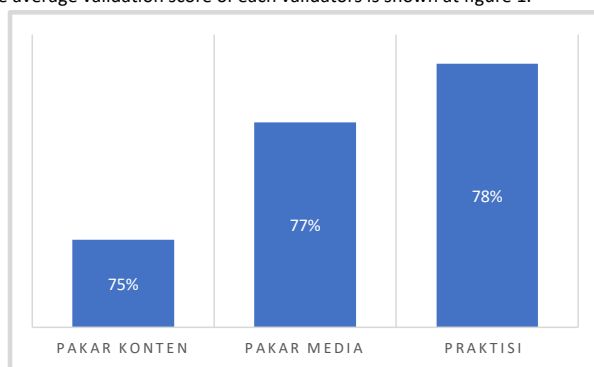
64 The research begin with a preliminary study which consist of activity such as problem identification activities by
65 conducting literature studies and analyzing pre-existing learning media. Pre-existing media emphasizes the aspects
66 of student interest in using learning media. Meanwhile, the development in this study is that adding the aspects of
67 critical thinking skills to the learning media that will be developed. It is necessary to collect data by conducting an
68 assessment of the material and an assessment of the media making device to overcome the problems found in the
69 previous stage. In making learning media used hardware and software.

70 The product developed is a learning media with an App inverter oriented to critical thinking skills. The
71 development of learning media is expected to facilitate educators and students in conducting learning interactions.
72 Students are expected to be able to study independently anywhere and anytime so that they can improve their
73 critical thinking skills. The main characteristic of the learning media developed consists of a cover page, which is
74 the page that first appears when the user opens the application on a smartphone, and the menu page is the core
75 page of the learning media. Therefore, it will be expected that from the cover could attract the user and also can
76 access all the menus presented on the learning media. The menu on the menu page contains chapter 1, chapter 2,
77 chapter 3, chapter 4 and chapter 5 as well as Info. The display of each chapter consists of concept maps, materials,
78 evaluations and videos, to display information containing instructions for use, about the author and a bibliography.
79 The structure and content which has been elaborated are the main characteristics as a differentiator from the
80 existing media.

81 The development of learning media can be categorized as a quality product if it meets the elements of valid,
82 appropriate and effective can be used in accordance with the objectives of media development. It should meet the
83 content and construct validity. The content validity relates to the relevance or novelty, and the construct validity
84 relates to consistency or program design logic [11]. The developed product is validated before tested by the
85 validators who are experts in their fields to ensure that the developed product can be scientifically justified and
86 the results can be used. It was validated by three validators who have expertise in their fields that is a lecturer of

87 Physics Education who was a material expert, a lecturer of Physics Education who was a media expert and a
88 Physics teacher of who was an expert practitioner. Each expert validation has its own aspect, namely the material
89 expert has assessment aspects such as content feasibility aspects, presentation feasibility aspects, and
90 implementation. Media experts have assessment aspects, namely visual communication aspects and software
91 engineering aspects. Meanwhile, expert practitioners have assessment aspects, namely the content of the
92 material, evaluation of the material, audio-visual communication and software engineering. Physics learning media
93 oriented by critical thinking skills is feasible to use if the validation score of each item percentage of the feasibility
94 in the level criteria of feasible or very feasible. If the assessment item is obtained as a percentage at the level
95 category not feasible or very inappropriate, then the physics learning media oriented to critical thinking skills is
96 said to be invalid or not feasible to use.

97 The first validator provides notes regarding to the feasibility of the product being developed with the average
98 of percentage of 75% with a feasible category and can be used with revisions. The recommendations and
99 suggestions from the first validator expert is that need the improvements of teaching materials in the writing of
100 concept map section. Therefore, the next step is to improve the writing on the concept map section. The second
101 validator gives a percentage score of the feasibility of the developed media is 77% with a very good category and
102 can be used with revisions. A note from the validator is that it needs improvements to the image size in the
103 application software. Therefore, the next step taken by researchers is to improve the size of the image in the
104 application software. The third validator provides an assessment with a percentage score of 78% with a very
105 feasible category and can be used with revisions. The suggestion from the third validator is to insert several
106 pictures in the text. The average validation score of each validators is shown at figure 1.

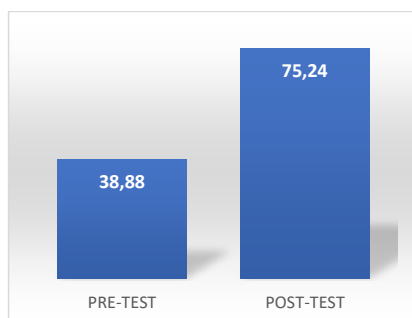


107 **Figure 1** The average of validation score the developed learning media

108
109
110 Based on the data that has been presented, the results of the validation of learning media by the three
111 validators get an average percentage score of 76.7, %. The percentage score is included in the valid category. This
112 shows that the developed learning media products oriented by critical thinking skills that meet the requirements
113 to be used for further testing with students.

114 Testing product development to students is intended to determine the effectiveness of the impact of the
115 developed media on students' critical thinking skills. In the implementation of the trial process, the data about
116 critical thinking skills were obtained by making observations in learning using android-based media in grade X at
117 even semesters. The observation process was carried out twice before and after using learning media. The results
118 obtained show that the learning media has increased N-Gain 0.6 in the medium category. The results of statistical
119 analysis of pre-test scores and post-test scores in the class showed that the pre-test scores did not increase.
120 However, the results show that after using learning media there is a significant difference. It can be strongly
121 suspected that the learning media has an impact on improving students' critical thinking skills. The results of the
122 study have strengthened the research that has been done by Syawaludin, et al.[12] stating that the effectiveness

123 of using learning media can improve students' critical thinking skills. The use of interactive android-based learning
 124 media affects students' critical thinking skills, making it easier for students to formulate problems, analyze, dig up
 125 information, evaluate information and find solutions. Meanwhile, the results of the critical thinking skills test in the
 126 pre-test and post-test stages are presented in figure 2.
 127



128 **Figure 2** The results of pre-test and post-test

129
 130
 131 In the implementation stage, the average pre-test score was 38.88 and the post-test score showed an average
 132 of 75.24, obtaining a gain criterion of 0.6 with moderate criteria. Based on the data above, it illustrates that the
 133 developed learning media have an impact on students' critical thinking skills. The impact of changes in critical
 134 thinking skills on students is caused by the use of developed learning media, the developed media creates the
 135 situations and learning stages that stimulate better of students' critical thinking skills. In detail the post-test results
 136 based on critical thinking skills indicators as presented in table 1.
 137
 138

Table 1. The scores of each critical thinking skill indicators

No	Critical thinking skill indicators	Average score
1.	Providing a simple explanation	8,3
2.	Identifying the assumption	6,7
3.	Concluding	7,1
4.	Analyzing	6,6
5.	Evaluating	7

139
 140 Based on the table 1, the indicators for analyzing obtain the lowest average score, meaning that students'
 141 ability to carry out analysis still requires assistance and further research can be carried out. Meanwhile, the
 142 average value of the indicator that obtain the highest score is the first indicator that is providing a simple
 143 explanation. The students are able to understand well and are able to give a brief explanation of the information
 144 presented by the media. It means that the media developed is very communicative and easy to understand. On
 145 average, it can be concluded that the application of android media has improved students' critical thinking skills.
 146 The use of thinking stages in the evaluation is a step in training students' critical thinking skills. The results are
 147 in line with the results of the study that thinking skills need guided practice because students rarely transfer these
 148 thinking skills themselves. In order the items written can require high-level thinking, then each item should be
 149 given a basic question (stimulus) in the form of a source/reading material [13, 14]. The study also stated that the
 150 use of android applications was effective in increasing interest, student learning outcomes in physics material, and
 151 critical thinking skills [15 -17].

152
153

CONCLUSION

154 Based on the results of the discussion, it can be concluded that the developed physics learning media is valid,
155 feasible and effective to improve students' critical thinking skills.

156
157

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4. **Bukti Konfirmasi Revisi Artikel
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







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1. ABSTRACT

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4	 accepted	21 Dec 2021 14:35:12	General comment: the script is in accordance with the AIP template  Review result (index.php?mod=author&content=fullpaper_my&p=2205&r=2141)

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Developing Learning Media of Physics Oriented by Critical Thinking Skills

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Nur Khoiri^{1 a)}, Diana Arin Wahyuningsih², and Duwi Nuvitalia³

^{1,2,3}Universitas PGRI Semarang

^{a)} Corresponding author: nurkhoiri@upgris.ac.id

Abstract. The research was carried out using the Research and Development method which includes define, design, develop, and dissemination. The data was collected using a questionnaire, the observation sheets and the tests. The results showed that the product development media is valid, feasible and effective in improving students' critical thinking skills. The percentage of validity score is 77% and the percentage score is 78%. The results of statistical analysis show that the developed learning media can improve students' critical thinking skills.

INTRODUCTION

The development of technology have had an impact on changes in various dimensions of human life, such as economic, social, cultural and educational. These changes result in a movement towards a balance of the new life order [1]. The challenge of a new life which is known as the 21st century requires the new types of skill. As a result of the demands for change also have an impact on learning orientation which has shifted as a result of changes in the new life order [2]. The skills needs of the current generation include critical thinking skills. Critical thinking skills are strongly suspected to be very important skills needed by the current generation [3]. One of those affected by this condition are the Teacher Trainer Institution (TTI) graduates or prospective teachers, since they teach the new generation in different ways from the knowledge provided to prospective teachers when they studied at TTI [4].

One of the challenges that require continuous innovation for prospective teachers is related to the learning media that will be used in the learning process [5]. Learning media is the tools that can be used to deliver the messages from the learning materials which are expected to stimulate attention and interest. Android-based learning media becomes one of the media in learning science that can be concreted by utilizing technological developments in the field of education. Android is a very complete platform in which of its operating system, applications and development tools. It has extremely high support from the open source community in the world; therefore, android continues to grow rapidly in terms of technology and the number of devices in the world [6]. Moreover, android is currently used by almost all school-age children, especially since the Covid-19 pandemic era. The use of Android has been accelerated as a means of online school. Therefore, it is a significant need to optimize the use of learning media through mobile learning by equipping the students with the particular skills which prepare them facing the education in 21st century [7].

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METHODS

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60 products to students.

61

RESULTS AND DISCUSSION

62
63

64 The research begin with a preliminary study which consist of activity such as problem identification activities by
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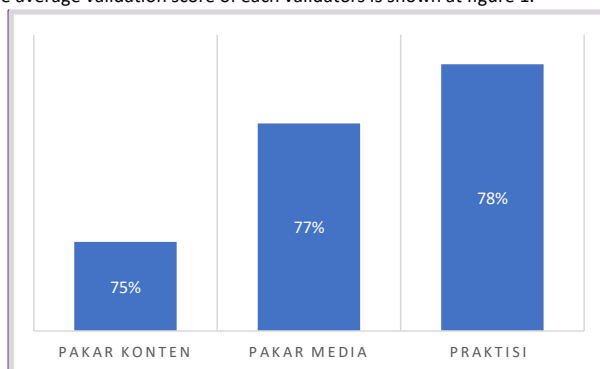
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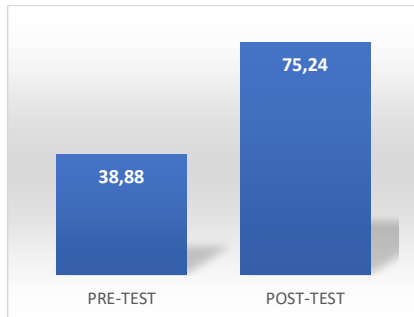
107 **Figure 1** The average of validation score the developed learning media

108
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128 **Figure 2** The results of pre-test and post-test

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 137
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Table 1. The scores of each critical thinking skill indicators

No	Critical thinking skill indicators	Average score
1.	Providing a simple explanation	8,3
2.	Identifying the assumption	6,7
3.	Concluding	7,1
4.	Analyzing	6,6
5.	Evaluating	7

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 150 use of android applications was effective in increasing interest, student learning outcomes in physics material, and
 151 critical thinking skills [15 -17].

152
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CONCLUSION

154 Based on the results of the discussion, it can be concluded that the developed physics learning media is valid,
155 feasible and effective to improve students' critical thinking skills.

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5. **Bukti Upload Artikel yang sudah di revisi (15 Desember 2021)**

Developing Learning Media of Physics Using MIT App Inventor to Improve the Critical Thinking Skills

Nur Khoiri^{1 a)}, Diana Arin Wahyuningsih², and Duwi Nuvitalia³

^{1,2,3}Universitas PGRI Semarang

^{a)} Corresponding author: nurkhoiri@upgris.ac.id

Abstract. The research was carried out using the Research and Development method which includes define, design, develop, and dissemination. The data was collected using a questionnaire, the observation sheets and the tests. The results showed that the product development media is valid, feasible and effective in improving students' critical thinking skills. The percentage of validity score is 77% and the percentage score is 78%. The results of statistical analysis show that the developed learning media can improve students' critical thinking skills, particularly in the designing part which facilitate students both analyzing and discussing in a comprehensive way.

INTRODUCTION

The development of technology have had an impact on changes in various dimensions of human life, such as economic, social, cultural and educational. These changes result in a movement towards a balance of the new life order [1]. The challenge of a new life which is known as the 21st century requires the new types of skill. As a result of the demands for change also have an impact on learning orientation which has shifted as a result of changes in the new life order [2]. The skills needs of the current generation include critical thinking skills. Critical thinking skills are strongly suspected to be very important skills needed by the current generation [3]. One of those affected by this condition are the Teacher Trainer Institution (TTI) graduates or prospective teachers, since they teach the new generation in different ways from the knowledge provided to prospective teachers when they studied at TTI [4].

One of the challenges that require continuous innovation for prospective teachers is related to the learning media that will be used in the learning process [5]. Learning media is the tools that can be used to deliver the messages from the learning materials which are expected to stimulate attention and interest. Android-based learning media becomes one of the media in learning science that can be concreted by utilizing technological developments in the field of education. Android is a very complete platform in which of its operating system, applications and development tools. It has extremely high support from the open source community in the world; therefore, android continues to grow rapidly in terms of technology and the number of devices in the world [6]. Moreover, android is currently used by almost all school-age children, especially since the Covid-19 pandemic era. The use of Android has been accelerated as a means of online school. Therefore, it is a significant need to optimize the use of learning media through mobile learning by equipping the students with the particular skills which prepare them facing the education in 21st century [7].

According to the TIMSS (Trends in International Mathematics and Science Study) 2015, the average percentage of Indonesian students' reasoning abilities was 26%, while the international average was 44%. According to Bloom's taxonomy, reasoning abilities are included in higher order thinking skills [8]. Critical thinking skills becomes a part of higher order thinking skills that important to acquire. However, regarding to the condition of the low critical thinking skills of students, it becomes a challenge and anxiety for educators in Indonesia to improve students' critical thinking skills as future generations. Therefore, it is important to do a research in developing learning media of physic which enable the teachers to create a conducive classroom so that increase the students' critical thinking skill.

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METHODS

44 This study involves the Research & Development model, which is a process carried out to develop and validate
45 the educational products [9]. The data collection techniques are questionnaires and tests. The development
46 research consists of four stages, namely define, design, develop and disseminate [10]. Define is a preliminary
47 activity that aims to collect all the information needed through field studies and literature to compile the initial
48 product. There are two activities in this stage namely a literature study which consist of material analysis and
49 media making devices, and the second activity is that the use of media that was developed. The material that
50 delivered in the media should appropriate to the standard competence (SK) and basic competence (KD). The
51 assessment process which includes SK/KD analysis, learning resources, material selection and user determination
52 is carried out simultaneously because it is interrelated and cannot stand alone. At this stage, data collection is
53 also carried out that is closely related to the material, media making devices and the use of media. *Design* is the
54 activity of making detailed specifications of the media to be made. A good and well-planned design will make it
55 easier to create further media. The media design was firstly designed in the form of a script then developed
56 which consists of objects that will be used in making learning media such as text, images and sound using the MIT
57 App Inventor software. *Develop* is an activity to develop a product in the form of an Android application that
58 contains materials, exercises and evaluations related to learning materials and critical thinking skills such that
59 resulting a product that is ready to be validated. At this stage, the validation of the learning media used the MIT
60 App Inventor. This validation consists of material, media and user. *Dissemination* is an activity to disseminate
61 products to students.

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RESULTS AND DISCUSSION

65 The research begin with a preliminary study which consist of activity such as problem identification activities by
66 conducting literature studies and analyzing pre-existing learning media. Pre-existing media emphasizes the aspects
67 of student interest in using learning media. Meanwhile, the development in this study is that adding the aspects of
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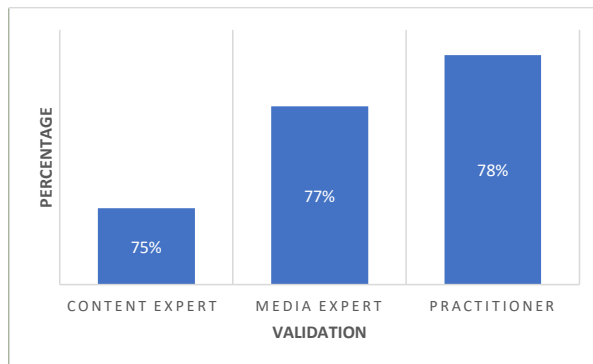
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108 changed at the appearance of the media become simpler but aesthetic with keep the aspect supporting students'
109 understanding.



110 **Figure 1** The average of validation score the developed learning media

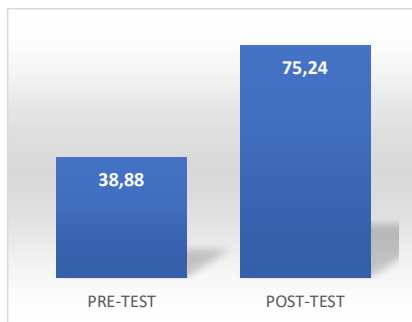
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156 use of android applications was effective in increasing interest, student learning outcomes in physics material, and
157 critical thinking skills [15 -17].

158 CONCLUSION

159

160 Based on the results of the discussion, it can be concluded that the developed physics learning media is valid,
161 feasible and effective to improve students' critical thinking skills. Therefore, the media facilitates the students with
162 the opportunity in data analyzing which trains and improve the students' critical thinking skill through discussion.

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Developing Learning Media of Physics Using MIT App Inventor to Improve the Critical Thinking Skills

Nur Khoiri^{1, a)}, Diana Arin Wahyuningsih¹, and Duwi Nuvitalia¹

^{1,2,3}Universitas PGRI Semarang

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Abstract. The research was carried out using the Research and Development method which includes define, design, develop, and dissemination. The data was collected using a questionnaire, the observation sheets and the tests. The results showed that the product development media is valid, feasible and effective in improving students' critical thinking skills. The percentage of validity score is 77% and the percentage score is 78%. The results of statistical analysis show that the developed learning media can improve students' critical thinking skills, particularly in the designing part which facilitate students both analyzing and discussing in a comprehensive way.

INTRODUCTION

The development of technology have had an impact on changes in various dimensions of human life, such as economic, social, cultural and educational. These changes result in a movement towards a balance of the new life order [1]. The challenge of a new life which is known as the 21st century requires the new types of skill. As a result of the demands for change also have an impact on learning orientation which has shifted as a result of changes in the new life order [2]. The skills needs of the current generation include critical thinking skills. Critical thinking skills are strongly suspected to be very important skills needed by the current generation [3]. One of those affected by this condition are the Teacher Trainer Institution (TTI) graduates or prospective teachers, since they teach the new generation in different ways from the knowledge provided to prospective teachers when they studied at TTI [4].

One of the challenges that require continuous innovation for prospective teachers is related to the learning media that will be used in the learning process [5]. Learning media is the tools that can be used to deliver the messages from the learning materials which are expected to stimulate attention and interest. Android-based learning media becomes one of the media in learning science that can be concreted by utilizing technological developments in the field of education. Android is a very complete platform in which of its operating system, applications and development tools. It has extremely high support from the open source community in the world; therefore, android continues to grow rapidly in terms of technology and the number of devices in the world [6]. Moreover, android is currently used by almost all school-age children, especially since the Covid-19 pandemic era. The use of Android has been accelerated as a means of online school. Therefore, it is a significant need to optimize the use of learning media through mobile learning by equipping the students with the particular skills which prepare them facing the education in 21st century [7].

According to the TIMSS (Trends in International Mathematics and Science Study) 2015, the average percentage of Indonesian students' reasoning abilities was 26%, while the international average was 44%. According to Bloom's taxonomy, reasoning abilities are included in higher order thinking skills [8]. Critical thinking skills becomes a part of higher order thinking skills that important to acquire. However, regarding to the condition of the low critical thinking skills of students, it becomes a challenge and anxiety for educators in Indonesia to improve students' critical thinking skills as future generations. Therefore, it is important to do a research in developing learning media of physics which enable the teachers to create a conducive classroom so that increase the students' critical thinking skill.

41

METHODS

42 This study involves the Research & Development model, which is a process carried out to develop and validate
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RESULTS AND DISCUSSION

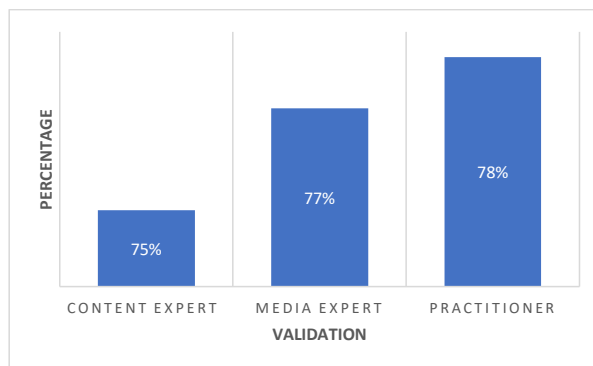
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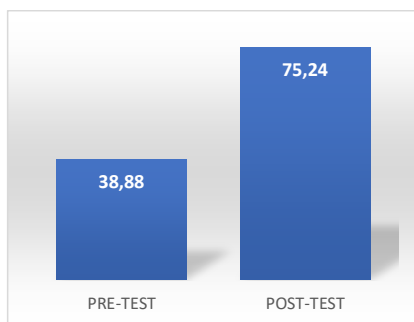


108 **FIGURE 1** The average of validation score the developed learning media
109
110

111 Based on the data that has been presented, the results of the validation of learning media by the three
112 validators get an average percentage score of 76.7, %. The percentage score is included in the valid category. This
113 shows that the developed learning media products oriented by critical thinking skills that meet the requirements
114 to be used for further testing with students. Moreover, the revise version of the prototype is more aesthetic,
115 simpler, without reducing the aspect that develop students' understanding. In the designing part, there is an
116 activity that involve the students to analyze the data which comprehensively form the students' critical thinking
117 skill habit through a discussion. Therefore, this media could train and improve the students' critical thinking skills.

118 Testing product development to students is intended to determine the effectiveness of the impact of the
119 developed media on students' critical thinking skills. In the implementation of the trial process, the data about
120 critical thinking skills were obtained by making observations in learning using android-based media in grade X at
121 even semesters. The observation process was carried out twice before and after using learning media. The results

122 obtained show that the learning media has increased N-Gain 0.6 in the medium category. The results of statistical
123 analysis of pre-test scores and post-test scores in the class showed that the pre-test scores did not increase.
124 However, the results show that after using learning media there is a significant difference. It can be strongly
125 suspected that the learning media has an impact on improving students' critical thinking skills. The results of the
126 study have strengthened the research that has been done by Syawaludin, et al.[12] stating that the effectiveness
127 of using learning media can improve students' critical thinking skills. The use of interactive android-based learning
128 media affects students' critical thinking skills, making it easier for students to formulate problems, analyze, dig up
129 information, evaluate information and find solutions. Meanwhile, the results of the critical thinking skills test in the
130 pre-test and post-test stages are presented in figure 2.
131



132
133 **FIGURE 2** The results of pre-test and post-test
134

135 In the implementation stage, the average pre-test score was 38.88 and the post-test score showed an average
136 of 75.24, obtaining a gain criterion of 0.6 with moderate criteria. Based on the data above, it illustrates that the
137 developed learning media have an impact on students' critical thinking skills. The impact of changes in critical
138 thinking skills on students is caused by the use of developed learning media, the developed media creates the
139 situations and learning stages that stimulate better of students' critical thinking skills. In detail the post-test results
140 based on critical thinking skills indicators as presented in table 1.
141

142 **TABLE 1.** The scores of each critical thinking skill indicators

No	Critical thinking skill indicators	Average score
1.	Providing a simple explanation	8.3
2.	Identifying the assumption	6.7
3.	Concluding	7.1
4.	Analyzing	6.6
5.	Evaluating	7

143
144 Based on the table 1, the indicators for analyzing obtain the lowest average score, meaning that students'
145 ability to carry out analysis still requires assistance and further research can be carried out. Meanwhile, the
146 average value of the indicator that obtain the highest score is the first indicator that is providing a simple
147 explanation. The students are able to understand well and are able to give a brief explanation of the information
148 presented by the media. It means that the media developed is very communicative and easy to understand. On
149 average, it can be concluded that the application of android media has improved students' critical thinking skills.

150 The use of thinking stages in the evaluation is a step in training students' critical thinking skills. The results are
151 in line with the results of the study that thinking skills need guided practice because students rarely transfer these
152 thinking skills themselves. In order the items written can require high-level thinking, then each item should be
153 given a basic question (stimulus) in the form of a source/reading material [13, 14]. The study also stated that the
154 use of android applications was effective in increasing interest, student learning outcomes in physics material, and
155 critical thinking skills [15 -17].

156

CONCLUSION

157 Based on the results of the discussion, it can be concluded that the developed physics learning media is valid,
158 feasible and effective to improve students' critical thinking skills. Therefore, the media facilitates the students with
159 the opportunity in data analyzing which trains and improve the students' critical thinking skill through discussion.

160

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Developing Learning Media of Physics Using MIT App Inventor to Improve the Critical Thinking Skills

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Abstract. The research was carried out using the Research and Development method which includes define, design, develop, and dissemination. The data was collected using a questionnaire, the observation sheets and the tests. The results showed that the product development media is valid, feasible and effective in improving students' critical thinking skills. The percentage of validity score is 77% and the percentage score is 78%. The results of statistical analysis show that the developed learning media can improve students' critical thinking skills, particularly in the designing part which facilitate students both analyzing and discussing in a comprehensive way.

INTRODUCTION

The development of technology have had an impact on changes in various dimensions of human life, such as economic, social, cultural and educational. These changes result in a movement towards a balance of the new life order [1]. The challenge of a new life which is known as the 21st century requires the new types of skill. As a result of the demands for change also have an impact on learning orientation which has shifted as a result of changes in the new life order [2]. The skills needs of the current generation include critical thinking skills. Critical thinking skills are strongly suspected to be very important skills needed by the current generation [3]. One of those affected by this condition are the Teacher Trainer Institution (TTI) graduates or prospective teachers, since they teach the new generation in different ways from the knowledge provided to prospective teachers when they studied at TTI [4].

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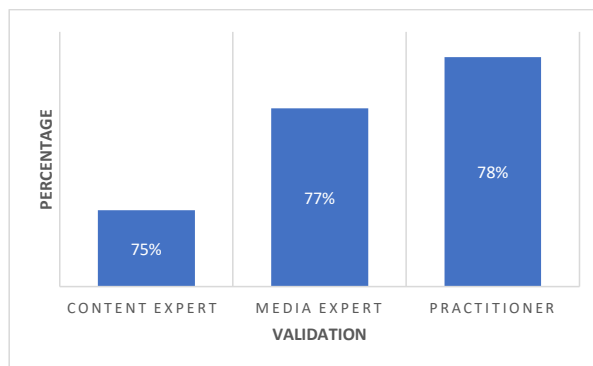
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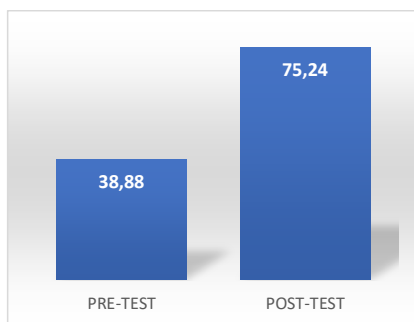


108 **FIGURE 1** The average of validation score the developed learning media
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 128 media affects students' critical thinking skills, making it easier for students to formulate problems, analyze, dig up
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 130 pre-test and post-test stages are presented in figure 2.
 131



132 **FIGURE 2** The results of pre-test and post-test

133
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 139 situations and learning stages that stimulate better of students' critical thinking skills. In detail the post-test results
 140 based on critical thinking skills indicators as presented in table 1.
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142 **TABLE 1.** The scores of each critical thinking skill indicators

No	Critical thinking skill indicators	Average score
1.	Providing a simple explanation	8.3
2.	Identifying the assumption	6.7
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 145 ability to carry out analysis still requires assistance and further research can be carried out. Meanwhile, the
 146 average value of the indicator that obtain the highest score is the first indicator that is providing a simple
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151 in line with the results of the study that thinking skills need guided practice because students rarely transfer these
152 thinking skills themselves. In order the items written can require high-level thinking, then each item should be
153 given a basic question (stimulus) in the form of a source/reading material [13, 14]. The study also stated that the
154 use of android applications was effective in increasing interest, student learning outcomes in physics material, and
155 critical thinking skills [15 -17].

156 CONCLUSION

157 Based on the results of the discussion, it can be concluded that the developed physics learning media is valid,
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9. Bukti Konfirmasi Artikel Terpilih
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Dear author,

Thank you for your contribution in 8th International Conference on Mathematics, Science, and Education (ICMSE 2021). We would like to inform that the selected manuscripts that published in American Institute of Physics (AIP) have been available at: <https://pubs.aip.org/aip/acp/issue/2614/1>.

We wait your participation in our next conference.

Regards,
ICMSE2021 Committee

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10. Preface AIP dan Artikel yang
publish di AIP Publishing Conference
Proceedings

The 8th International Conference on Mathematics, Science and Education 2021

Semarang, Indonesia • 5–6 October 2021

Editors • Sugianto, Kinya Shimizu, Edy Cahyono, Masturi,
Cher Ping Lam and Shafiq Aazmi



RESEARCH ARTICLE | JUNE 16 2023

Preface: International Conference on Mathematics, Science and Education (ICMSE) **FREE**



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Preface: International Conference on Mathematics, Science and Education (ICMSE)

International Conference on Mathematics, Science and Education (ICMSE) is the international conference hosted by Faculty of Mathematics and Natural Sciences Universitas Negeri Semarang and Co-Host by UiTM and Association of Mathematics and Natural Science Teacher Training Institute Indonesia (AMLI). The eighth conference brought the theme of Opportunities and Challenges for Research and Innovation in Mathematics, Science, and Education in Post-Pandemic Era. This conference presented the discussion of the challenge of research and education in pandemic era. The conference was conducted virtually to prevent the spread of the virus on 5-6 October 2021.

The invited speakers from five countries consisting of Ezza Syuhada Binti S., Ph.D (Universiti Teknologi Malaysia, Malaysia), Shafieq Aazmi, Ph.D (Universiti Teknologi Mara, Malaysia), Dr. Yasmi Louhasakul (Yala Rajabhat University, Thailand), Prof. Kinya Shimizu (Hiroshima University, Japan), Prof. Cher Ping Lim (The Education University of Hong Kong, Hong Kong), Zaenal Abidin, Ph.D. (Universitas Negeri Semarang, Indonesia) delivered their talk through video conference. All keynote speakers shared the material from their countries as well as the participants.

The participants consisted of several presenters and participants coming from several universities in Indonesia and some other countries Malaysia, Thailand, Japan, India, French, Egypt, and Bangladesh. There were three sessions which involved opening, invited speaker presentation and authors' parallel presentation. Opening session consisting of keynote speech and opening remark lasted 20 minutes, followed by each invited speaker presentation for 20 minutes and each author presentation took 10 minutes. The breakout rooms were provided to facilitate authors in presenting their research result. There were 14 rooms for parallel session which is guided by one moderator to lead the discussion. Participants still could involve themselves in the intellectual discussion in invited speakers and parallel sessions although the conference was conducted virtually as they could write the question through chat box or directly deliver their question.

In addition, I would like to acknowledge all of supporting teams, especially to the organizing committee members and reviewers, for their great contribution in conference organization. We hope that this program will further encourage research publication in Mathematics and Science Education and build trust relationship. We feel honoured and privileged to serve the best recent developments in the field of Mathematics and Science Education to you through this exciting program.

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Developing Learning Media of Physics Using MIT App Inventor to Improve the Critical Thinking Skills

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Abstract. The research was carried out using the Research and Development method which includes define, design, develop, and dissemination. The data was collected using a questionnaire, the observation sheets and the tests. The results showed that the product development media is valid, feasible and effective in improving students' critical thinking skills. The percentage of validity score is 77% and the percentage score is 78%. The results of statistical analysis show that the developed learning media can improve students' critical thinking skills, particularly in the designing part which facilitate students both analyzing and discussing in a comprehensive way.

INTRODUCTION

The development of technology have had an impact on changes in various dimensions of human life, such as economic, social, cultural and educational. These changes result in a movement towards a balance of the new life order [1]. The challenge of a new life which is known as the 21st century requires the new types of skill. As a result of the demands for change also have an impact on learning orientation which has shifted as a result of changes in the new life order [2]. The skills needs of the current generation include critical thinking skills. Critical thinking skills are strongly suspected to be very important skills needed by the current generation [3]. One of those affected by this condition are the Teacher Trainer Institution (TTI) graduates or prospective teachers, since they teach the new generation in different ways from the knowledge provided to prospective teachers when they studied at TTI [4].

One of the challenges that require continuous innovation for prospective teachers is related to the learning media that will be used in the learning process [5]. Learning media is the tools that can be used to deliver the messages from the learning materials which are expected to stimulate attention and interest. Android-based learning media becomes one of the media in learning science that can be concreted by utilizing technological developments in the field of education. Android is a very complete platform in which of its operating system, applications and development tools. It has extremely high support from the open source community in the world; therefore, android continues to grow rapidly in terms of technology and the number of devices in the world [6]. Moreover, android is currently used by almost all school-age children, especially since the Covid-19 pandemic era. The use of Android has been accelerated as a means of online school. Therefore, it is a significant need to optimize the use of learning media through mobile learning by equipping the students with the particular skills which prepare them facing the education in 21st century [7].

According to the TIMSS (Trends in International Mathematics and Science Study) 2015, the average percentage of Indonesian students' reasoning abilities was 26%, while the international average was 44%. According to Bloom's taxonomy, reasoning abilities are included in higher order thinking skills [8]. Critical thinking skills becomes a part of higher order thinking skills that important to acquire. However, regarding to the condition of the low critical thinking skills of students, it becomes a challenge and anxiety for educators in Indonesia to improve students' critical thinking skills as future generations. Therefore, it is important to do a research in developing learning media of physic which enable the teachers to create a conducive classroom so that increase the students' critical thinking skill.

METHODS

This study involves the Research & Development model, which is a process carried out to develop and validate the educational products [9]. The data collection techniques are questionnaires and tests. The development research consists of four stages, namely define, design, develop and disseminate [10]. Define is a preliminary activity that aims to collect all the information needed through field studies and literature to compile the initial product. There are two activities in this stage namely a literature study which consist of material analysis and media making devices, and the second activity is that the use of media that was developed. The material that delivered in the media should appropriate to the standard competence (SK) and basic competence (KD). The assessment process which includes SK/KD analysis, learning resources, material selection and user determination is carried out simultaneously because it is interrelated and cannot stand alone. At this stage, data collection is also carried out that is closely related to the material, media making devices and the use of media. *Design* is the activity of making detailed specifications of the media to be made. A good and well-planned design will make it easier to create further media. The media design was firstly designed in the form of a script then developed which consists of objects that will be used in making learning media such as text, images and sound using the MIT App Inventor software. *Develop* is an activity to develop a product in the form of an Android application that contains materials, exercises and evaluations related to learning materials and critical thinking skills such that resulting a product that is ready to be validated. At this stage, the validation of the learning media used the MIT App Inventor. This validation consists of material, media and user. *Dissemination* is an activity to disseminate products to students.

RESULTS AND DISCUSSION

The research begin with a preliminary study which consist of activity such as problem identification activities by conducting literature studies and analyzing pre-existing learning media. Pre-existing media emphasizes the aspects of student interest in using learning media. Meanwhile, the development in this study is that adding the aspects of critical thinking skills to the learning media that will be developed. It is necessary to collect data by conducting an assessment of the material and an assessment of the media making device to overcome the problems found in the previous stage. In making learning media used hardware and software.

The product developed is a learning media with an App inverter oriented to critical thinking skills. The development of learning media is expected to facilitate educators and students in conducting learning interactions. Students are expected to be able to study independently anywhere and anytime so that they can improve their critical thinking skills. The main characteristic of the learning media developed consists of a cover page, which is the page that first appears when the user opens the application on a smartphone, and the menu page is the core page of the learning media. Therefore, it will be expected that from the cover could attract the user and also can access all the menus presented on the learning media. The menu on the menu page contains chapter 1, chapter 2, chapter 3, chapter 4 and chapter 5 as well as Info. The display of each chapter consists of concept maps, materials, evaluations and videos, to display information containing instructions for use, about the author and a bibliography. The structure and content which has been elaborated are the main characteristics as a differentiator from the existing media.

The development of learning media can be categorized as a quality product if it meets the elements of valid, appropriate and effective can be used in accordance with the objectives of media development. It should meet the content and construct validity. The content validity relates to the relevance or novelty, and the construct validity relates to consistency or program design logic [11]. The developed product is validated before tested by the validators who are experts in their fields to ensure that the developed product can be scientifically justified and the results can be used. It was validated by three validators who have expertise in their fields that is a lecturer of Physics Education who was a material expert, a lecturer of Physics Education who was a media expert and a Physics teacher of who was an expert practitioner. Each expert validation has its own aspect, namely the material expert has assessment aspects such as content feasibility aspects, presentation feasibility aspects, and implementation. Media experts have assessment aspects, namely visual communication aspects and software engineering aspects. Meanwhile, expert practitioners have assessment aspects, namely the content of the material, evaluation of the material, audio-visual communication and software engineering. Physics learning media oriented by critical thinking skills is feasible to use if the validation score of each item percentage of the feasibility in the level criteria of feasible or very feasible. If the assessment item is obtained as a percentage at the level category not feasible or very inappropriate, then the physics learning media oriented to critical thinking skills is said to be invalid or not feasible to use.

The first validator provides notes regarding to the feasibility of the product being developed with the average of percentage of 75% with a feasible category and can be used with revisions. The recommendations and suggestions from the first validator expert is that need the improvements of teaching materials in the writing of concept map section. Therefore, the next step is to improve the writing on the concept map section. The second validator gives a percentage score of the feasibility of the developed media is 77% with a very good category and can be used with revisions. A note from the validator is that it needs improvements to the image size in the application software. Therefore, the next step taken by researchers is to improve the size of the image in the application software. The third validator provides an assessment with a percentage score of 78% with a very feasible category and can be used with revisions. The suggestion from the third validator is to insert several pictures in the text. The average validation score of each validators is shown at figure 1. Overall, the product changed at the appearance of the media become simpler but aesthetic with keep the aspect supporting students' understanding.

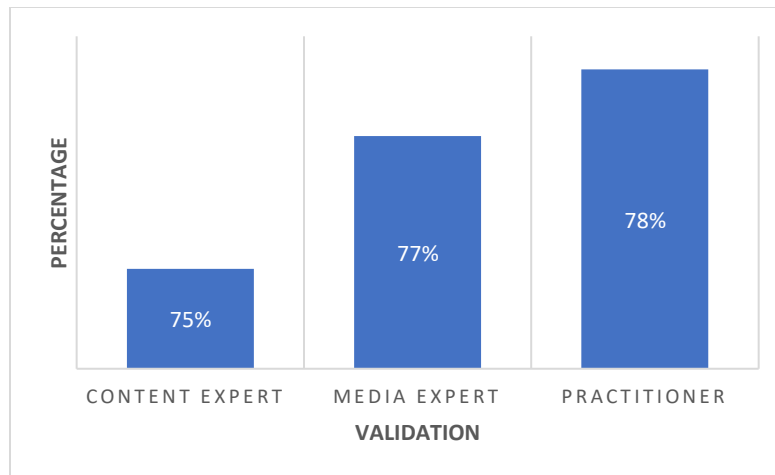


FIGURE 1 The average of validation score the developed learning media

Based on the data that has been presented, the results of the validation of learning media by the three validators get an average percentage score of 76.7, %. The percentage score is included in the valid category. This shows that the developed learning media products oriented by critical thinking skills that meet the requirements to be used for further testing with students. Moreover, the revise version of the prototype is more aesthetic, simpler, without reducing the aspect that develop students' understanding. In the designing part, there is an activity that involve the students to analyze the data which comprehensively form the students' critical thinking skill habit through a discussion. Therefore, this media could train and improve the students' critical thinking skills.

Testing product development to students is intended to determine the effectiveness of the impact of the developed media on students' critical thinking skills. In the implementation of the trial process, the data about critical thinking skills were obtained by making observations in learning using android-based media in grade X at even semesters. The observation process was carried out twice before and after using learning media. The results obtained show that the learning media has increased N-Gain 0.6 in the medium category. The results of statistical analysis of pre-test scores and post-test scores in the class showed that the pre-test scores did not increase. However, the results show that after using learning media there is a significant difference. It can be strongly suspected that the learning media has an impact on improving students' critical thinking skills. The results of the study have strengthened the research that has been done by Syawaludin, et al.[12] stating that the effectiveness of using learning media can improve students' critical thinking skills. The use of interactive android-based learning media affects students' critical thinking skills, making it easier for students to formulate problems, analyze, dig up information, evaluate information and find solutions. Meanwhile, the results of the critical thinking skills test in the pre-test and post-test stages are presented in figure 2.

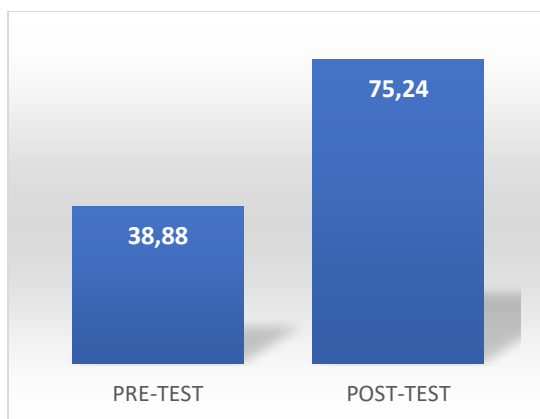


FIGURE 2 The results of pre-test and post-test

In the implementation stage, the average pre-test score was 38.88 and the post-test score showed an average of 75.24, obtaining a gain criterion of 0.6 with moderate criteria. Based on the data above, it illustrates that the developed learning media have an impact on students' critical thinking skills. The impact of changes in critical thinking skills on students is caused by the use of developed learning media, the developed media creates the situations and learning stages that stimulate better of students' critical thinking skills. In detail the post-test results based on critical thinking skills indicators as presented in table 1.

TABLE 1. The scores of each critical thinking skill indicators

No	Critical thinking skill indicators	Average score
1.	Providing a simple explanation	8.3
2.	Identifying the assumption	6.7
3.	Concluding	7.1
4.	Analyzing	6.6
5.	Evaluating	7

Based on the table 1, the indicators for analyzing obtain the lowest average score, meaning that students' ability to carry out analysis still requires assistance and further research can be carried out. Meanwhile, the average value of the indicator that obtain the highest score is the first indicator that is providing a simple explanation. The students are able to understand well and are able to give a brief explanation of the information presented by the media. It means that the media developed is very communicative and easy to understand. On average, it can be concluded that the application of android media has improved students' critical thinking skills.

The use of thinking stages in the evaluation is a step in training students' critical thinking skills. The results are in line with the results of the study that thinking skills need guided practice because students rarely transfer these thinking skills themselves. In order the items written can require high-level thinking, then each item should be given a basic question (stimulus) in the form of a source/reading material [13, 14]. The study also stated that the use of android applications was effective in increasing interest, student learning outcomes in physics material, and critical thinking skills [15 -17].

CONCLUSION

Based on the results of the discussion, it can be concluded that the developed physics learning media is valid, feasible and effective to improve students' critical thinking skills. Therefore, the media facilitates the students with the opportunity in data analyzing which trains and improve the students' critical thinking skill through discussion.

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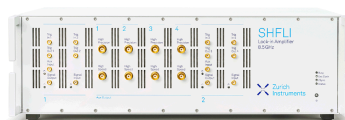

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Developing Learning Media of Physics Using MIT App Inventor to Improve the Critical Thinking Skills

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Abstract. The research was carried out using the Research and Development method which includes define, design, develop, and dissemination. The data was collected using a questionnaire, the observation sheets and the tests. The results showed that the product development media is valid, feasible and effective in improving students' critical thinking skills. The percentage of validity score is 77% and the percentage score is 78%. The results of statistical analysis show that the developed learning media can improve students' critical thinking skills, particularly in the designing part which facilitate students both analyzing and discussing in a comprehensive way.

INTRODUCTION

The development of technology have had an impact on changes in various dimensions of human life, such as economic, social, cultural and educational. These changes result in a movement towards a balance of the new life order [1]. The challenge of a new life which is known as the 21st century requires the new types of skill. As a result of the demands for change also have an impact on learning orientation which has shifted as a result of changes in the new life order [2]. The skills needs of the current generation include critical thinking skills. Critical thinking skills are strongly suspected to be very important skills needed by the current generation [3]. One of those affected by this condition are the Teacher Trainer Institution (TTI) graduates or prospective teachers, since they teach the new generation in different ways from the knowledge provided to prospective teachers when they studied at TTI [4].

One of the challenges that require continuous innovation for prospective teachers is related to the learning media that will be used in the learning process [5]. Learning media is the tools that can be used to deliver the messages from the learning materials which are expected to stimulate attention and interest. Android-based learning media becomes one of the media in learning science that can be concreted by utilizing technological developments in the field of education. Android is a very complete platform in which of its operating system, applications and development tools. It has extremely high support from the open source community in the world; therefore, android continues to grow rapidly in terms of technology and the number of devices in the world [6]. Moreover, android is currently used by almost all school-age children, especially since the Covid-19 pandemic era. The use of Android has been accelerated as a means of online school. Therefore, it is a significant need to optimize the use of learning media through mobile learning by equipping the students with the particular skills which prepare them facing the education in 21st century [7].

According to the TIMSS (Trends in International Mathematics and Science Study) 2015, the average percentage of Indonesian students' reasoning abilities was 26%, while the international average was 44%. According to Bloom's taxonomy, reasoning abilities are included in higher order thinking skills [8]. Critical thinking skills becomes a part of higher order thinking skills that important to acquire. However, regarding to the condition of the low critical thinking skills of students, it becomes a challenge and anxiety for educators in Indonesia to improve students' critical thinking skills as future generations. Therefore, it is important to do a research in developing learning media of physic which enable the teachers to create a conducive classroom so that increase the students' critical thinking skill.

METHODS

This study involves the Research & Development model, which is a process carried out to develop and validate the educational products [9]. The data collection techniques are questionnaires and tests. The development research consists of four stages, namely define, design, develop and disseminate [10]. Define is a preliminary activity that aims to collect all the information needed through field studies and literature to compile the initial product. There are two activities in this stage namely a literature study which consist of material analysis and media making devices, and the second activity is that the use of media that was developed. The material that delivered in the media should appropriate to the standard competence (SK) and basic competence (KD). The assessment process which includes SK/KD analysis, learning resources, material selection and user determination is carried out simultaneously because it is interrelated and cannot stand alone. At this stage, data collection is also carried out that is closely related to the material, media making devices and the use of media. *Design* is the activity of making detailed specifications of the media to be made. A good and well-planned design will make it easier to create further media. The media design was firstly designed in the form of a script then developed which consists of objects that will be used in making learning media such as text, images and sound using the MIT App Inventor software. *Develop* is an activity to develop a product in the form of an Android application that contains materials, exercises and evaluations related to learning materials and critical thinking skills such that resulting a product that is ready to be validated. At this stage, the validation of the learning media used the MIT App Inventor. This validation consists of material, media and user. *Dissemination* is an activity to disseminate products to students.

RESULTS AND DISCUSSION

The research begin with a preliminary study which consist of activity such as problem identification activities by conducting literature studies and analyzing pre-existing learning media. Pre-existing media emphasizes the aspects of student interest in using learning media. Meanwhile, the development in this study is that adding the aspects of critical thinking skills to the learning media that will be developed. It is necessary to collect data by conducting an assessment of the material and an assessment of the media making device to overcome the problems found in the previous stage. In making learning media used hardware and software.

The product developed is a learning media with an App inverter oriented to critical thinking skills. The development of learning media is expected to facilitate educators and students in conducting learning interactions. Students are expected to be able to study independently anywhere and anytime so that they can improve their critical thinking skills. The main characteristic of the learning media developed consists of a cover page, which is the page that first appears when the user opens the application on a smartphone, and the menu page is the core page of the learning media. Therefore, it will be expected that from the cover could attract the user and also can access all the menus presented on the learning media. The menu on the menu page contains chapter 1, chapter 2, chapter 3, chapter 4 and chapter 5 as well as Info. The display of each chapter consists of concept maps, materials, evaluations and videos, to display information containing instructions for use, about the author and a bibliography. The structure and content which has been elaborated are the main characteristics as a differentiator from the existing media.

The development of learning media can be categorized as a quality product if it meets the elements of valid, appropriate and effective can be used in accordance with the objectives of media development. It should meet the content and construct validity. The content validity relates to the relevance or novelty, and the construct validity relates to consistency or program design logic [11]. The developed product is validated before tested by the validators who are experts in their fields to ensure that the developed product can be scientifically justified and the results can be used. It was validated by three validators who have expertise in their fields that is a lecturer of Physics Education who was a material expert, a lecturer of Physics Education who was a media expert and a Physics teacher of who was an expert practitioner. Each expert validation has its own aspect, namely the material expert has assessment aspects such as content feasibility aspects, presentation feasibility aspects, and implementation. Media experts have assessment aspects, namely visual communication aspects and software engineering aspects. Meanwhile, expert practitioners have assessment aspects, namely the content of the material, evaluation of the material, audio-visual communication and software engineering. Physics learning media oriented by critical thinking skills is feasible to use if the validation score of each item percentage of the feasibility in the level criteria of feasible or very feasible. If the assessment item is obtained as a percentage at the level category not feasible or very inappropriate, then the physics learning media oriented to critical thinking skills is said to be invalid or not feasible to use.

The first validator provides notes regarding to the feasibility of the product being developed with the average of percentage of 75% with a feasible category and can be used with revisions. The recommendations and suggestions from the first validator expert is that need the improvements of teaching materials in the writing of concept map section. Therefore, the next step is to improve the writing on the concept map section. The second validator gives a percentage score of the feasibility of the developed media is 77% with a very good category and can be used with revisions. A note from the validator is that it needs improvements to the image size in the application software. Therefore, the next step taken by researchers is to improve the size of the image in the application software. The third validator provides an assessment with a percentage score of 78% with a very feasible category and can be used with revisions. The suggestion from the third validator is to insert several pictures in the text. The average validation score of each validators is shown at figure 1. Overall, the product changed at the appearance of the media become simpler but aesthetic with keep the aspect supporting students' understanding.

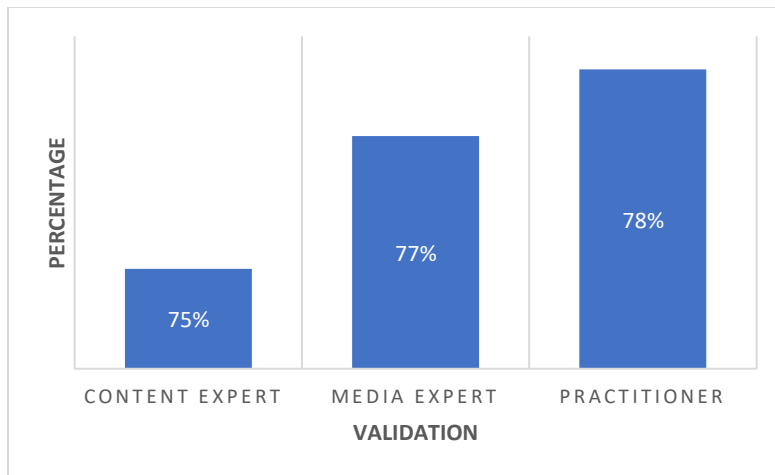


FIGURE 1 The average of validation score the developed learning media

Based on the data that has been presented, the results of the validation of learning media by the three validators get an average percentage score of 76.7, %. The percentage score is included in the valid category. This shows that the developed learning media products oriented by critical thinking skills that meet the requirements to be used for further testing with students. Moreover, the revise version of the prototype is more aesthetic, simpler, without reducing the aspect that develop students' understanding. In the designing part, there is an activity that involve the students to analyze the data which comprehensively form the students' critical thinking skill habit through a discussion. Therefore, this media could train and improve the students' critical thinking skills.

Testing product development to students is intended to determine the effectiveness of the impact of the developed media on students' critical thinking skills. In the implementation of the trial process, the data about critical thinking skills were obtained by making observations in learning using android-based media in grade X at even semesters. The observation process was carried out twice before and after using learning media. The results obtained show that the learning media has increased N-Gain 0.6 in the medium category. The results of statistical analysis of pre-test scores and post-test scores in the class showed that the pre-test scores did not increase. However, the results show that after using learning media there is a significant difference. It can be strongly suspected that the learning media has an impact on improving students' critical thinking skills. The results of the study have strengthened the research that has been done by Syawaludin, et al.[12] stating that the effectiveness of using learning media can improve students' critical thinking skills. The use of interactive android-based learning media affects students' critical thinking skills, making it easier for students to formulate problems, analyze, dig up information, evaluate information and find solutions. Meanwhile, the results of the critical thinking skills test in the pre-test and post-test stages are presented in figure 2.

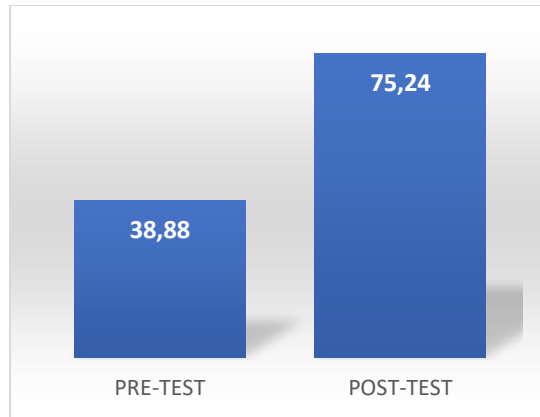


FIGURE 2 The results of pre-test and post-test

In the implementation stage, the average pre-test score was 38.88 and the post-test score showed an average of 75.24, obtaining a gain criterion of 0.6 with moderate criteria. Based on the data above, it illustrates that the developed learning media have an impact on students' critical thinking skills. The impact of changes in critical thinking skills on students is caused by the use of developed learning media, the developed media creates the situations and learning stages that stimulate better of students' critical thinking skills. In detail the post-test results based on critical thinking skills indicators as presented in table 1.

TABLE 1. The scores of each critical thinking skill indicators

No	Critical thinking skill indicators	Average score
1.	Providing a simple explanation	8.3
2.	Identifying the assumption	6.7
3.	Concluding	7.1
4.	Analyzing	6.6
5.	Evaluating	7

Based on the table 1, the indicators for analyzing obtain the lowest average score, meaning that students' ability to carry out analysis still requires assistance and further research can be carried out. Meanwhile, the average value of the indicator that obtain the highest score is the first indicator that is providing a simple explanation. The students are able to understand well and are able to give a brief explanation of the information presented by the media. It means that the media developed is very communicative and easy to understand. On average, it can be concluded that the application of android media has improved students' critical thinking skills.

The use of thinking stages in the evaluation is a step in training students' critical thinking skills. The results are in line with the results of the study that thinking skills need guided practice because students rarely transfer these thinking skills themselves. In order the items written can require high-level thinking, then each item should be given a basic question (stimulus) in the form of a source/reading material [13, 14]. The study also stated that the use of android applications was effective in increasing interest, student learning outcomes in physics material, and critical thinking skills [15 -17].

CONCLUSION

Based on the results of the discussion, it can be concluded that the developed physics learning media is valid, feasible and effective to improve students' critical thinking skills. Therefore, the media facilitates the students with the opportunity in data analyzing which trains and improve the students' critical thinking skill through discussion.

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