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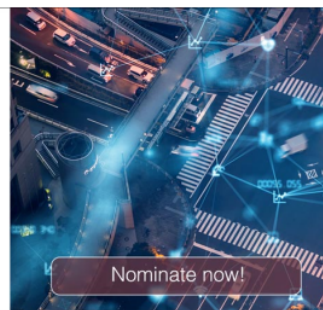


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Multimedia development based on web connected Massive Open Online Courses (cMOOCs) on the basic physics material

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Abstract. This research aimed to develop multimedia as an infrastructure in the world of cMOOCs web-based education on the material of basic physics I to improve students' independent learning. The research method used was research and development using the ADDIE (Analyze-Design-Development-Implementation-Evaluation) model. The objects in this study were 31 students in the physics education program at Jakarta State University. The research instruments used were material expert validation sheets, multimedia expert validation sheets, multiple-choice questions, and students' self-study questionnaire. The results of the validation of the material experts showed 94.19% (very good). The results of multimedia expert validation showed 78.33% (good). Then, the results of small group trials get a score of 82.67%, and the results of large group trials show 90.03%. And, The results of the assessment of the effectiveness of web cMOOCs on basic physics material I, obtained N-gain on mechanical material by a score of 0.818, N-gain on oscillation material and mechanical waves obtained a score of 0.831, N-gain on thermodynamic material obtained a score of 0.711 on average of the three materials this was 0.786 so it was a very high category. This showed the score of students' independent learning outcomes was increased. In addition, the results of the self-study questionnaire showed that the initiative aspect got a score of 85%, the business aspect itself was 88% and the responsibility aspect was 97%. According to data analysis and discussion, the multimedia improvement on the material of basic physics I with a small group trial was 82.67%, while in a large group trial was 90.03%. Therefore, it can be used as multimedia learning. Besides, developing cMOOCs web-based multimedia can also improve learners' independent learning with the initiative aspect is 85%, the business aspect itself is 88%, and the responsibility aspect is 97% with an average overall score of 90%.

1. Introduction

The development of technology in the industrial era 4.0 is growing rapidly. All sectors, including education, are required to be integrated with technology as a system to create highly competitive human resources [1]. Along with the influx of globalization, education will be more open and bi-directional, diverse, multidisciplinary, and related to competitive work productivity [2].

In the *Republika* daily with the topic, IndonesiaX and Padjajaran University launched free online courses, explained that IndonesiaX partnered with Padjajaran University (Unpad) provide Massive



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Open Online Courses (MOOC) which give access to free online courses for everybody in Indonesia. Free online learning in IndonesiaX.co.id is aimed to equalize education in Indonesia for everyone [3].

Besides, various studies have also been carried out. cMOOCs provide an opportunity for participants to create good collaboration so that it can help them hone and develop skills in the digital age. CMOOCs can survive because of the transformation of participants to build connections between fellow participants [4].

CMOOCs can be used as a tool that functions to explore and develop personal knowledge, skills, and attitudes through the content provided and can also be used as a place to build connections between participants through discussion spaces so to exchange ideas [5].

The participation of students in cMOOCs can make them challenged to develop their abilities and increase their motivation. CMOOCs also require students to play an active role in the spirit of openness to shape activities and collaborate with fellow participants to achieve the expected goals [6].

The technological capability of pedagogical content knowledge (TPACK) in prospective physics teacher-students is needed in the industrial era 4.0 to improve their skills and abilities. Utilizing cMOOCs web-based multimedia makes them challenged to develop their skills and increase their motivation. cMOOCs also require students to play an active role in the spirit of openness to shape activities and collaborate with fellow participants to achieve the expected goals [7].

Observation results also showed that UT has provided some certified online course material on the web moocs.ut.ac.id. These materials include introductory module 2.9, parenting, marketing management, and distance education. On the web CMOOCs, basic physics materials have not been provided.

Distribution of questionnaires through google form was spread to respondents across several universities throughout Indonesia, including Jakarta State University, Malang State University, Sebelas Maret University, Sanata Dharma University, Bengkulu University, and other universities. Out of 64 (sixty-four) respondents, 57.1% stated that their lecturers had used online learning media, 52.45% had not. Online learning media is generally in the form of websites (85.9%) but these websites generally only contain material in the form of pdf files, no videos, animations and also simulations. On the web, there is no discussion forum generally, but there are questions as evaluation of learning outcomes. In general, certificates are not yet available as proof of participant graduation.

In addition, 82.8% of respondents stated that the cMOOCs web was not used as a learning tool, 93.8% stated that cMOOCs web-based learning media needed to be developed. In general the respondents also often use laptops/computers or gadgets to access learning information with the internet. 92.2% of respondents also said that learning media was able to encourage them to learn independently.

Multimedia is tools that can create dynamic and interactive presentations that combine text, graphics, animation, audio, and video images. In other word, multimedia is defined as a collection of media that is a combination of media that is relevant to instructional purposes [8]. According to Daryanto, multimedia learning can be used to channel a variety of information so that it can stimulate the feelings, attention, and willingness of students to achieve learning objectives [9].

Meanwhile, according to Custandi, multimedia is a combination of several inputs or outputs media from data or a combination of several elements. Multimedia also merges back some media to deliver information. The combination of these media is text, graphics, animation, images, video and sound [10].

Based on some of the descriptions above, it can be synthesized that multimedia is the use of some media in the form of text, graphics, animation, images, video, and sound to convey information, messages or material to users so that it seems interesting.

a web is a multimedia-based technology that allows one to access more than just text, download images, audio, video, and animation and engage in interactive games [11]. Also according to Adelheid, a web is a collection of interesting information media to visit [12].

CMOOCs are part of MOOCs which are open online courses, available to a large number of participants for free. In MOOCs students not only interact with educators but also they can interact

with fellow participants through discussion forums. Communication is built between participants that can encourage them to help one another. So, the construction of collective knowledge is no longer a simple transmission of knowledge information [13].

Independent learning is an improvement of knowledge, skills, achievements, or personal development that is chosen and carried out by one's own efforts using any method in any condition; the ability to set learning goals, to take action to meet those goals and to evaluate learning effectiveness and learning outcomes [14].

This web-based multimedia can be used as an infrastructure in the world of education that provides positive benefits for anyone who wants to learn informally, independently, discuss with fellow users through cyberspace, access information more freely, especially for students.

Based on the description above, therefore a study titled "Development of Web-Based Multimedia cMOOCs on Basic Physics I Materials to Increase Student Self-Study" will be conducted. The objectives of this research are (1) to develop multimedia as an infrastructure in the world of cMOOCs web-based education on basic physics material I and (2) to increase students' independent learning.

2. Methodology

The method used was research and development that referred to the ADDIE model. The stages were based on the ADDIE model [15]. The instruments used in this study were the validation sheet for basic physicists I, multimedia expert validation sheets, multiple-choice physics basic I questions which included material mechanics, oscillations and mechanic waves, and thermodynamics and Student independent learning questionnaire. The items used were validated using the product-moment formula and the reliability used the KR-20 formula. Data analysis was performed using a Likert scale to measure people's opinions and perceptions [16]. To determine the percentage of success used following equation (1).

$$P = \frac{S}{N} \times 100\%$$

Where: P: Percentage of success (%)

S: The amount of the acquisition value

N: The maximum number of values

The data obtained were then written down on the interpretation of the scores below [16].

Table 1. Likert scale

Average Score	Interpretation
0%-20%	Not good
21%-40%	Less good
41%-60%	Enough
61%-80%	Well
81%-100%	Very good

The Pearson product moment formula could be seen in equation (2) below [17].

$$r_{yx} = \frac{n \sum XY - (\sum X)(\sum Y)}{\sqrt{\{(n \sum X^2) - (\sum X)^2\} \{(n \sum Y^2) - (\sum Y)^2\}}}$$

Where: r: Relationship Coefficient

n: amount of data

$\sum x$: Number of Variable Scores X

$\sum y$: Total Y Variable Score

KR-20 for internal reliability items could be seen in equation (3) below [18].

$$r_{11} = \left(\frac{n}{n-1} \right) \left(\frac{s^2 - \sum pq}{S^2} \right)$$

Where:

1: Overall test reliability

p: Proportion of subjects answering items correctly

q: Proportion of subjects answering items incorrectly ($q = 1-p$)

$\sum pq$: Number of times the results of p and q product

n: Many items

S: Standard deviation of the test (standard deviation is the root variance)

Analysis of the ability improvement of students after participating in learning with **1** N-gain calculated using Equation (4) as follows **13** [10].

$$N - \text{Gain} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximal Score} - \text{Pretest Score}}$$

1 The results of the N-gain calculation were categorized into 3 (three) categories [20], namely:

High : N-gain > 0.7

Medium : 0.3 gain N-gain \geq 0.7

Low : N-gain < 0.3

3. Results and discussions

The product of the development was the web cMOOCs as multimedia on learning basic physics I. The main components on this web were administrators, it has a role to view student data, teacher data, add teacher accounts, as well as receiving instructors, add/update teachers and edit pages front of the website. Teachers (educators) have a role in applying teaching data, updating material data following the teaching application, managing exam questions, and weighting values. Students are students as participants in the learning process.

In addition to the main components above, the features found on the cMOOCs web were registers, logins, homes, materials provided, discussion forums and certificates, news events, about us, and testimonials. Web Photos of cMOOCs that have been developed:

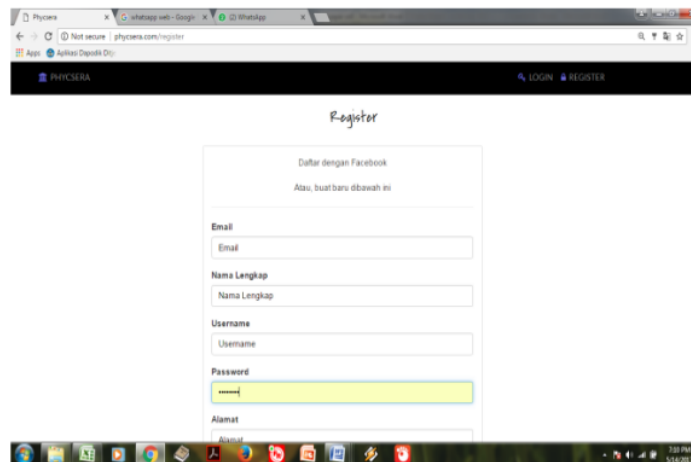


Figure 1. Display register feature

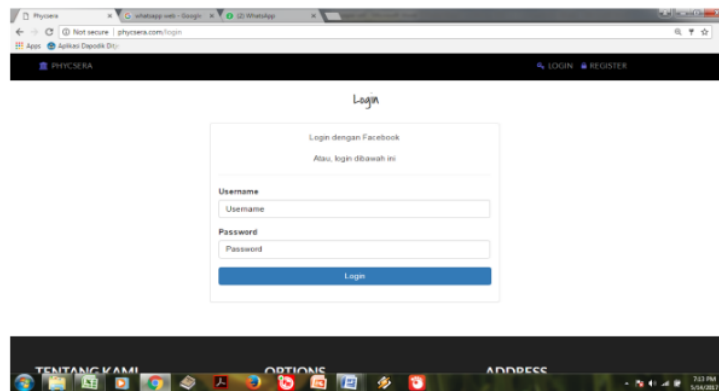


Figure 2. Display login feature

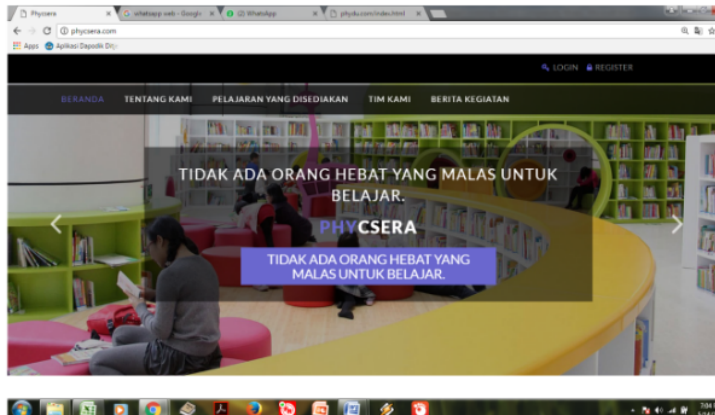


Figure 3. Display home features

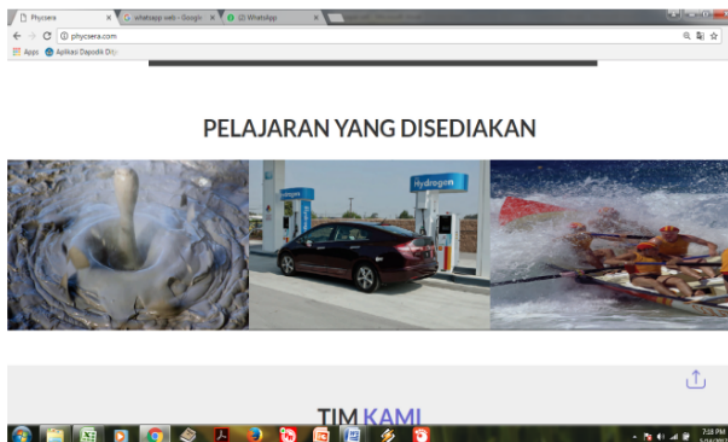


Figure 4. Display of the lesson features provided

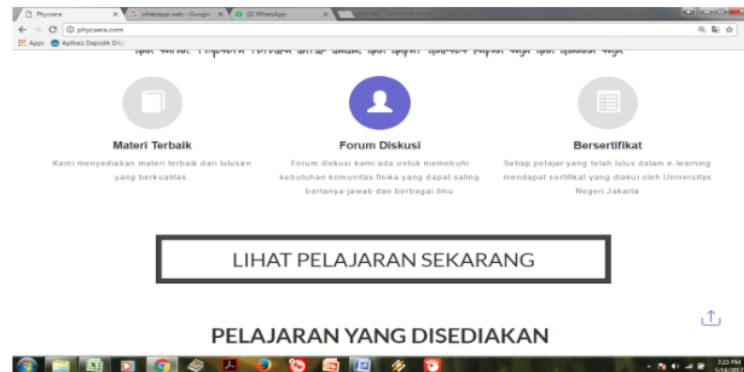


Figure 5. Display of discussion forum and certificate features



Figure 6. Display of activity news features

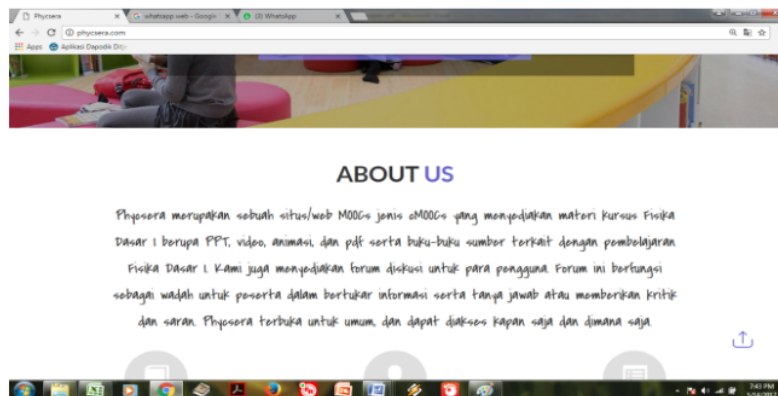


Figure 7. Display features about us

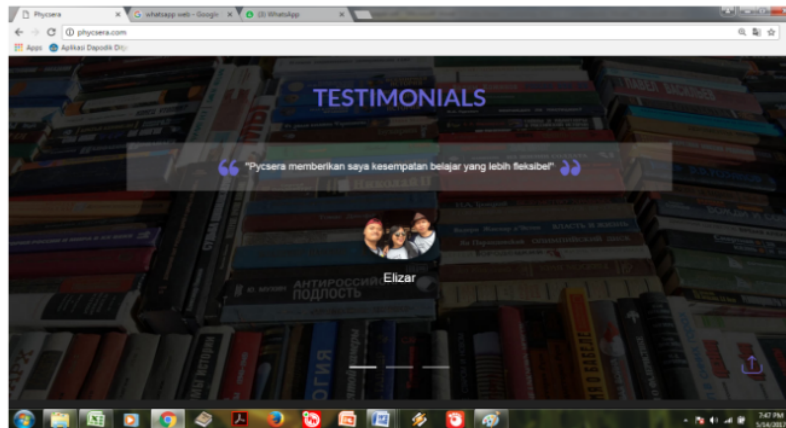


Figure 8. Display testimonials feature

The products of this web development results through a series of tests that were the material feasibility test, multimedia, and small group trials and large groups. The instrument had fulfilled aspects of validity with an average of 0.765 and reliability with an average of 0.933 [17].

The material feasibility test was conducted by two material experts who were physics lecturers. The results of the material feasibility test are displayed in the following figure (9).

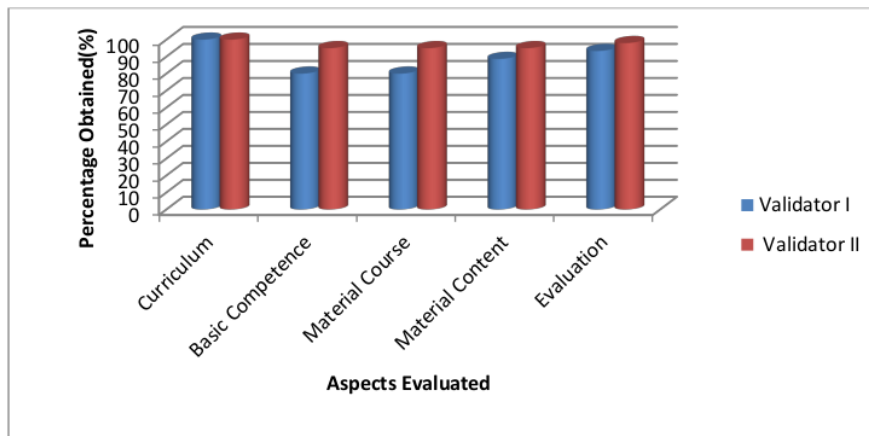


Figure 9. Material feasibility test results

Based on the graph above, the overall percentage of material feasibility test is 92.69%. The feasibility of the material was in the range of 81% - 100%. So, based on the Likert scale obtained was very good criteria [16]. The suggestions which were given by validators I and II were to add exam questions which defined fast-wave propagation video shown that comes from a credible source.

The multimedia feasibility test was conducted by two multimedia experts. The results of the material feasibility test are displayed in the following figure (10).

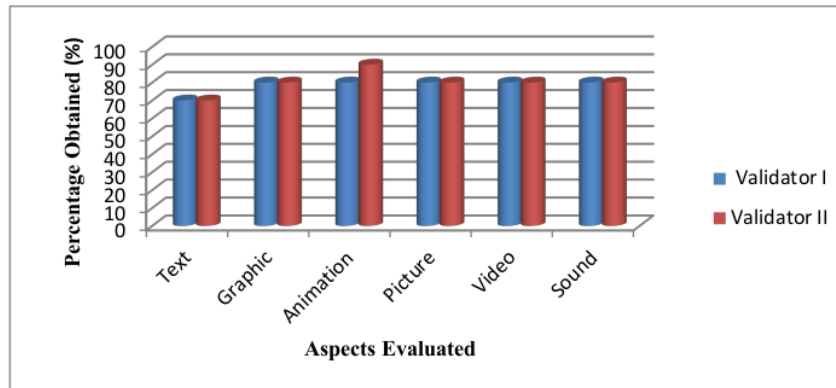


Figure 10. Results of the multimedia expert feasibility test

Based on the overall percentage graph, the results of the media feasibility test is equal to 78.33%, the material eligibility was in the range of 61% -80%, so it is considered as good criteria [16]. Suggestions for improvement given by the validators were in the learning section provided, where the picture did not represent the title. Also, Drawings were disproportionate, the part about us the form of letters was not read clearly, the material size of the letters was too small and giving numbers according to the order of the material.

Suggestions given by the material and multimedia validators are considered very useful. So, improvements have been made according to the advice given, before the basic physics material I and multimedia web cMOOCs are implemented on students.

The results of a small group trial of 5 students can be seen in figure (11) below.

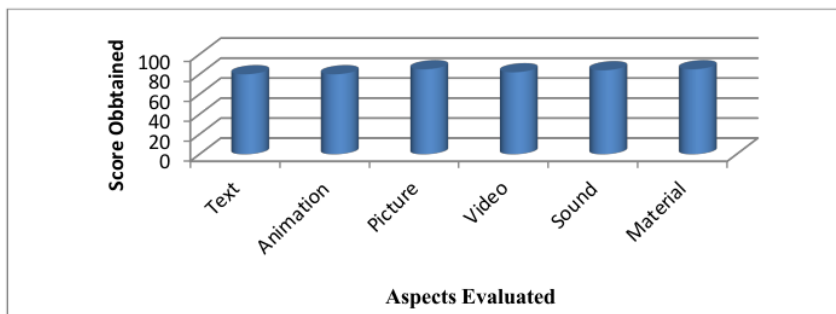


Figure 11. Results of small group trials

The picture above shows that aspects of the text, animation, images, video, sound, and material. The results indicated the overall average was 82.67% so that it is categorized as an excellent category [16].

The results of a large group trial of 31 students can be seen in figure (12) below.

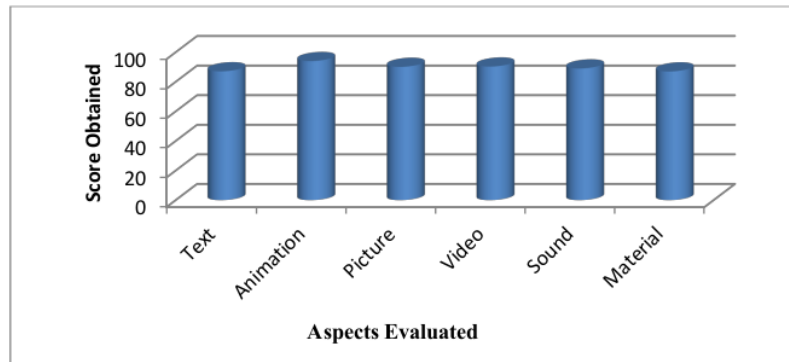


Figure 12. Results of large group trials

The picture above shows that aspects of the text, animation, images, video, sound, and material is at an average of 90.03%. It means that it belongs to the excellent category [16].

Based on the N-gain calculations that have been done, the N-gain for basic physics I consist of mechanics of 0.818, oscillations and mechanical waves of 0.831, and thermodynamics of 0.711 so that an average score of $g \geq 0.786$ was obtained. Thus, the obtained N-gain score is in the very high category [20].

In addition to measuring the increase in students' independent learning, the questionnaire was also used to find out aspects of students' independent learning. The results of the self-study questionnaire can be seen in the picture (13) below.

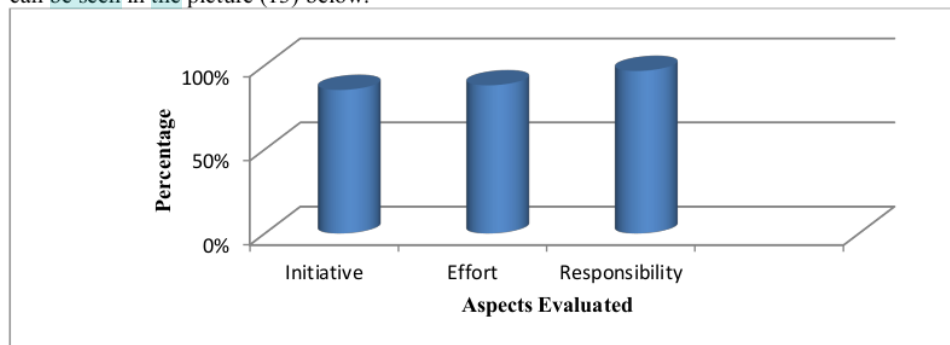


Figure 13. Aspects of independent learning

Based on the graph above, the initiative aspect is 85%, the effort aspect itself is 88%, and the responsibility aspect is 97%. The overall score is 90% so it is in very good criteria [16].

From the explanation above, the cMOOCs web development research is also supported by several supporting factors, including 1) the existence of cooperation and time tolerance in granting research permits by the study program coordinator, the active participation of students in learning and working on quiz questions and material related to research; 2) the willingness of students to divide their time in compulsory learning at Jakarta State University and take part in online learning on the web, and communication has been established between participants in discussion forums that help each other and share knowledge related to the material studied. This is in line with previous research which stated that cMOOCs require students to play an active role in the spirit of openness to shape activities and collaborate with fellow participants to achieve the expected goals [6]. It is also in accordance with previous research which concluded that cMOOCs provide an opportunity for participants to create good collaboration thus it can help them hone and develop skills in the digital age [4]; 3) students have

tried their best as expected. This is proved in the results of their independent learning. As in previous studies, it can be concluded that with maximum effort in the search for information will help students to achieve their goals [21].

Besides the supporting factors outlined above, there are also several inhibiting factors in the study. This was known based on a questionnaire distributed to respondents after the end of learning on phycsera.com. The inhibiting factors are: 1) inadequate and less stable internet network so that it takes time to access online learning; 2) the tight schedule of normal lectures on campus cause students have difficulty in allocating time; 3) limited internet quota owned by students to access online learning.

Another factor that has not been occurred was the maximum communication on discussion forums or social media, even there has been a delivery of information via Wikipedia and the YouTube link.

4. Conclusion

According to the results of data analysis and discussion, it can be concluded that the development of multimedia as an infrastructure in the world of cMOOCs web-based education on basic physics I can be used as learning multimedia. It is in the results of a small group trial of 82.67% and the results of a group trial of 90.03%. Besides, developing web-based multimedia cMOOCs can also improve students' independent learning with the initiative aspect is 85%, the effort aspect itself is 88%, and the responsibility aspect is 97% with an average overall score of 90%

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