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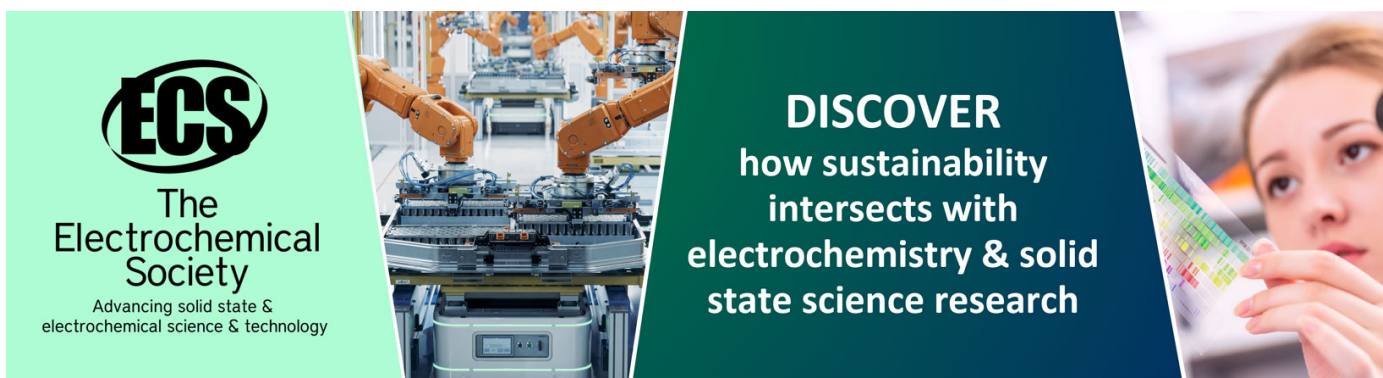
Development of connected massive open online course (cMOOCs) based on multimedia for thermodynamics subject to improve students' self-directed learning outcomes

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Development of connected massive open online course (cMOOCs) based on multimedia for thermodynamics subject to improve students' self-directed learning outcomes

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Abstract. This research aims to develop a *connected Massive Open Online Course (cMOOCs)* based on multimedia for thermodynamics subject to improve students' self-directed learning outcomes. Self-directed learning is for students to improve skill, gain achievement and knowledge, or self development and taken by self effort with any methods in any situation; ability to determine a learning goal, take an action to achieve that goal and evaluate learning effectivity of learning and learning outcomes. cMOOCs is an open online course that is free for many users to participate. This research subject is Thermodynamics related to heat and calor, temperature, thermodynamics laws, and energy exchange. This research method used ADDIE model with the following steps: Analyzing, Designing, Developing, Implementing, and Evaluating. Research was conducted in Physics education departement, State University of Jakarta for six months, started from October 2018 until April 2019. Students' self-directed learning outcomes improvement test was conducted by pre-test and post-test in two classes (class A and class B) with n-gain result of class A by 0.75 (high) and class B by 0.34 (medium). Results of validation test showed score 93.33% for material validation, 92.59% for media validation, and 92.60% for learning validation. It can be concluded that developed cMOOCs can improve students' self-directed learning outcomes.

1. Introduction

Globalization and information disclosure give a positive impact on education. Education is not only faces the change of fact and substance data, but also challenged to find an approaching, strategy, and learning method that able to answer education needs. Therefore, utilization of information and communication technology (ICT) in education has developed so fast. Education will be more open and two way, diverse, multi discipliner and related to competitive productivity along with the effects of globalization [5]. Student's abilities after students received a learning experience are called learning outcomes [12].

One of benefit from contribution of ICT is internet. Internet was used a lot as a source of information to support education. Besides the internet, smartphones were also developed fast. This supported by data which shows that smartphone user in Indonesia has increased by 43%. Cited from kominfo.go.id, according to E-marketer, in 2018 estimated number of active smartphone user in Indonesia is more than 100 million people. Interactive technology will be a catalyst for occurrence of change in the role



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teachers, from information to transformation and students activity from passive to be more active in order to access new knowledge [10]. Also, online university platform in England recorded that there were one million students registered for their lectures [6]. Meanwhile, in research about *cMOOCs And Global Learning: An Authentic Alternative* explained that cMOOCs can be used as media to explore and develop knowledge, skill, and individual behavior through provided contents and also can be used as place to build connection through discussion forum [1].

In a research study by Kristina concluded that students' participation in cMOOCs based e-learning encouraged students to develop self-ability and improved their motivation [7]. cMOOCs also demands students to be more active in activity and collaborating with other participants in order to achieve their goals.

Development of smartphones utilized in education by development of mobile applications. Mobile applications make students possible to access multimedia resources easily and learn almost everywhere. Technology has an important role in learning activity.

By the development of technology, education is no more limited by time and space. Homeschooling is an informal education that can be an alternative in learning on elementary and middle level. As for high level education, students can access *Massive Open Online Course (MOOCs)* that developed by University for free. MOOCs consists of xMOOCs (*Extended Massive Open Online Course*) and cMOOCs.

2. Literature Review

Online learning has increased fast for past fifteen years with students participating in a course. One of newest development which enables hundred and thousands students to participate at the same time in a course is MOOCs that offered by institutions also has spread throughout the world.

Characteristic of MOOCs are openness variation, obstacles to persistence, and paedagogic structure. High school dropout rate shows that learning obstacles are significant challenge. In Indonesia, application of MOOCs have been developed. IndonesiaX is a MOOCs platform with the most sophisticated learning management system. MOOCs that was developed by universities in Indonesia is still a few. It's expected that MOOCs developed in this research can be utilized for Physics Education students, State University of Jakarta.



Figure 1. Display of www.indonesiadx.co.id

Education is a continuous effort done by human in order to achieve a certain goal in their life. Education experienced a big development by the development of information communication and technology, as well as human needs for a high quality and effective education. Development of technology in past few years has changed society's paradigm in searching and achieve an information, which is not limited to printed media, but also internet.

Meanwhile, the development of technology in education has triggered a shift of conventional face to face learning to online learning that can be accessed through computer and internet by everyone regardless the place. This online learning has also developed in Indonesia. Online based learning has grown so fast. It can be seen by growth of MOOCs user. MOOCs has successfully attracted a lot of users, exceeding Facebook and Twitter. Until December 2012, applicants of Coursera course has reached more than two million. Every week, there are 70,000 applicants for 200 courses offered. Only in four months since launched, Coursera can hold 33 partner universities in development of course material, and attracted 16 million USD of investment. Development of MOOCs triggers the occurrence of many MOOCs platforms such as Edx, Udacity, Canvas, Iversity, Open learning, and Udemy. Each MOOCs has different characteristic.

According to Maha Bali, cMOOCs gives an opportunity to participants to create a good collaboration in order to develop their skill in digital era [8]. cMOOCs can survive because of participants' tranformation to build a connection between participants. Kristina concluded that participation of students in cMOOCs can encourage them to develop their own skill and increase their motivation. cMOOCs also demands participants to be actively collaborate with another user in order to achieve their goals.

This research more focused to development of cMOOCs based on multimedia for thermodynamics subject that was expected to improve students' self-directed learning outcomes.

Learning material on thermodynamics subject includes Interpreting thermodynamics phenomenon, Analyzing zeroth law of thermodynamics, Analyzing pure substance properties, Applying state equation of thermodynamics systems, Analyzing work done by or to the system, Analyzing heat and first law of thermodynamics, Ideal Gases Real Gases, Analyzing second law of thermodynamics, Analyzing entropy, Analyzing thermodynamics potential, enthalpy, Helmholtz and Gibbs [3].

Meanwhile, in Djoko Rahardjo's research on Internet Access and Usage in Improving Students' Open-University Self-Directed Learning in Indonesia concluded that lack of access to information affects the results of Open University students' self-directed learning in Indonesia [9]. But with maximum effort in information seeking will help students to achieve their learning goals. One of the efforts made the use of social media as an alternative to support their self-directed learning and achieve the expected goals. Whereas in this study the emphasis was on developing multimedia products in the form of web based on cMOOCs and still limited for thermodynamics subject. In addition, it is also expected to be able to improve students' self-directed learning.

Meanwhile according to Mehmet Firat's research on Web Interface Design Principles For Adults' Self-Directed Learning concluded that web interfaces designed with the features in it must support self-directed learning [2]. The web interface must also provide communication from various environments that allow participants to collaborate and share information, so this can support the achievement of the participants' self-directed learning goals. Whereas in this research, the emphasis was on developing multimedia products in the form of web based on cMOOCs for thermodynamic subject. In addition, it is also expected to be able to improve students' self-directed learning outcomes.

3. Research method

This research used *research and development* (R&D) method with ADDIE model. Steps of ADDIE model that is used are:

3.1 Analysis

Analysis is the first step in ADDIE model. In this step program designer have to do a need analysis to collect information related to problems faced by students in undergraduate degree.

3.2 Design

Design is the second step in ADDIE model where researcher designs the e-learning with cMOOCs characteristic so that students are expected to achieve goals and competence of following subject.

3.3 Development

Development is the third step in ADDIE model. In this step, learning materials for e-learning are produced and developed.

3.4 Implementation

Implementation is the fourth step in ADDIE. In this step, instructor implemented the e-learning in class according to teaching plan.

3.5 Evaluation

Evaluation is the last step in ADDIE model. In this step, e-learning is evaluated in order to improve its efficiency and effectiveness. Based on this evaluation results any improvements are done to perfects the e-learning [8].

Research instruments that were used in this research are learning material expert validation sheet, e-learning expert validation sheet, learning validation sheet, pre-test and post-test questions. All these instruments can be seen at <http://vinnarrai.com>.

4. Result and discussion

4.1 Results

Product of this research is cMOOCs based on multimedia vinnarrai.com as thermodynamics e-learning. This website is open to the public and can be accessed anytime and anywhere. Main components of this website are:

- Administrator. Administrator organizes students data, teachers data, hire teachers, and updates website.
- Lecturers. Lecturers apply learning data, updates learning materials, and organizes test questions and score.
- Students. Students attend online learning in vinnarrai.com such as taking quizzes, final exam, discussion forum and information sharing with another user through social media. Student must register to login vinnarrai.com.

Features in vinnarrai.com are: 1)Main page, 2)Register, 3>Login, 4)Learning Materials, 5)Exercise.



Figure 2. main page



Figure 3. register page



Figure 4. login page



Figure 5. Learning Materials



Figure 6. Exercise page

Table 1. Learning Material Expert's Validation Results

ASPECT	Expert 1	Expert 2	Expert 3
Accuracy of Material	88.00%	92.00%	100%
Delivery of Material	93.33%	93.33%	93.33%
Language usage	86.67%	93.33%	100%
Basic Competencies on Curriculum	90.00%	90.00%	100%
Average Percentage	89.23%	92.30%	98.46%
Overall Percentage	93.33%		

Validation by experts referred to Likert scale interval. Likert scale is used to measure behavior, opinion, and perception about social issue or phenomena [11]. Obtained data then interpreted as follows:

Table 2. Likert scale [13]

Average Score	Interpretation
0%-20%	Very Bad
21%-40%	Bad
41%-60%	Enough
61%-80%	Good
81%-100%	Very Good

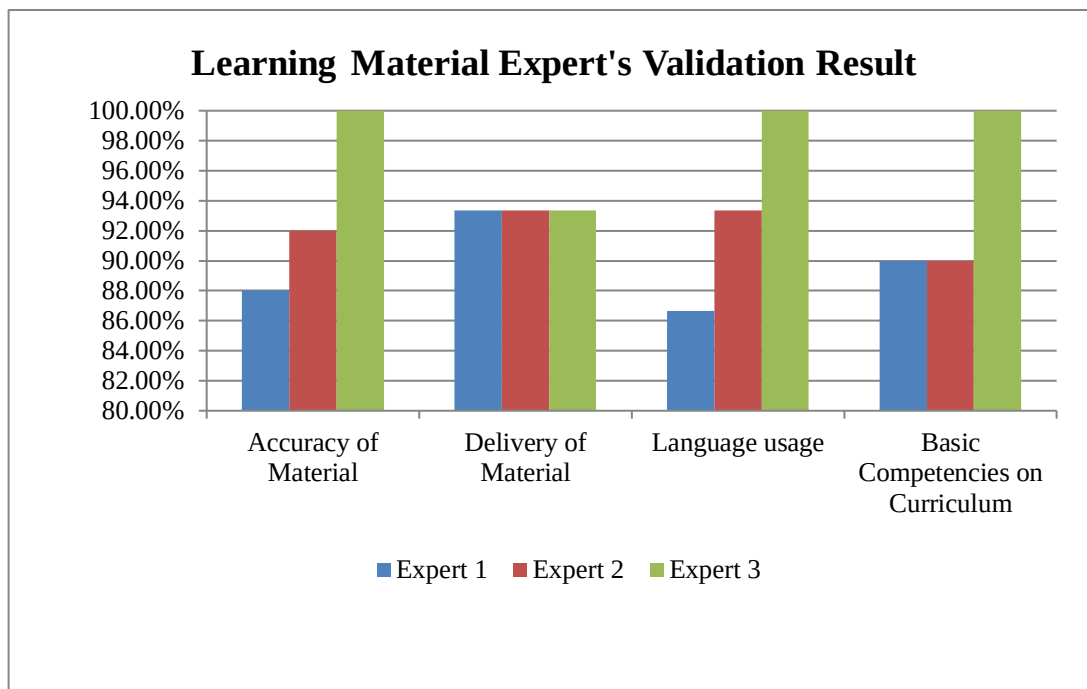


Figure 7. Learning Material Expert's Validation Results

Validation result by learning material expert shows average score by 89.23% according to material expert 1, 92.30% according to material expert 2 and 98.46% according to material expert 3. Overall validation result is 93.33%. Based on this result, the developed cMOOCs is considered worthy of use for thermodynamics. Media expert's validation result was shown on table 3.

Table 3. E-learning Expert's Validation Result

ASPECT	Category	Expert		
		1	2	3
Display	1	4	5	5
	2	5	4	4
	3	4	5	4
	4	5	5	4
	5	4	4	5
Media Usage	6	5	4	5
	7	4	5	5
	8	5	5	5
	9	5	5	5
Average Score		91,11%	93,33%	93,33%
Overall Score		92,59%		

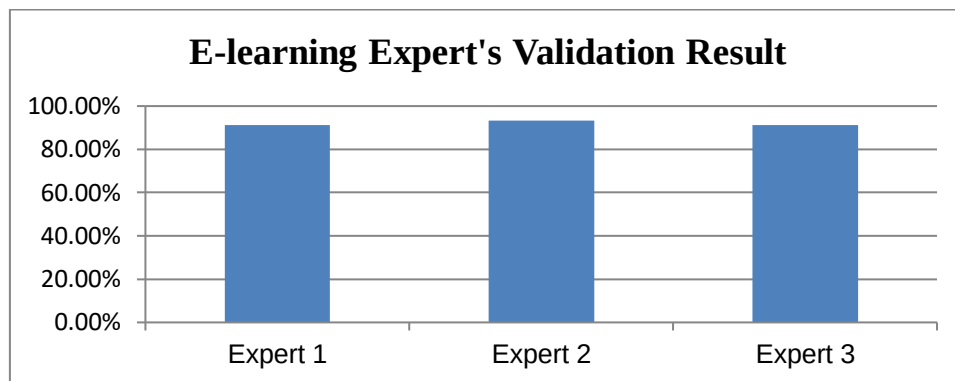


Figure 8. E-learning Expert's Validation Result

The results of three e-learning expert's validation were 91.11% by expert 1, 93.33% by expert 2, and 93.33% by expert 3. Overall validation result obtained is 92.59%. From this result can be concluded that the developed cMOOCs can be used in thermodynamics learning.

By referring to Likert scale, the result of learning expert's validation at table 4.

Table 4. Learning Expert's Validation Result

INDICATOR	EXPERT 1	EXPERT 2	EXPERT 3
cMOOCs creates an effective learning environment	4	5	5
cMOOCs makes students experience an exciting learning process	5	4	5
cMOOCs accelerates the learning	4	5	4
cMOOCs increases students' understanding	5	5	5
cMOOCs increases students' confidence	4	4	5
cMOOCs increases students' success rate in solving HOTS questions	5	4	5
cMOOCs makes students understand Thermodynamics easily	4	5	4
cMOOCs makes students more focus	5	5	5
cMOOCs makes students catch the concepts easily	5	4	5
Average	91,11%	91,11%	95,56%
Overall Score	92,59%		

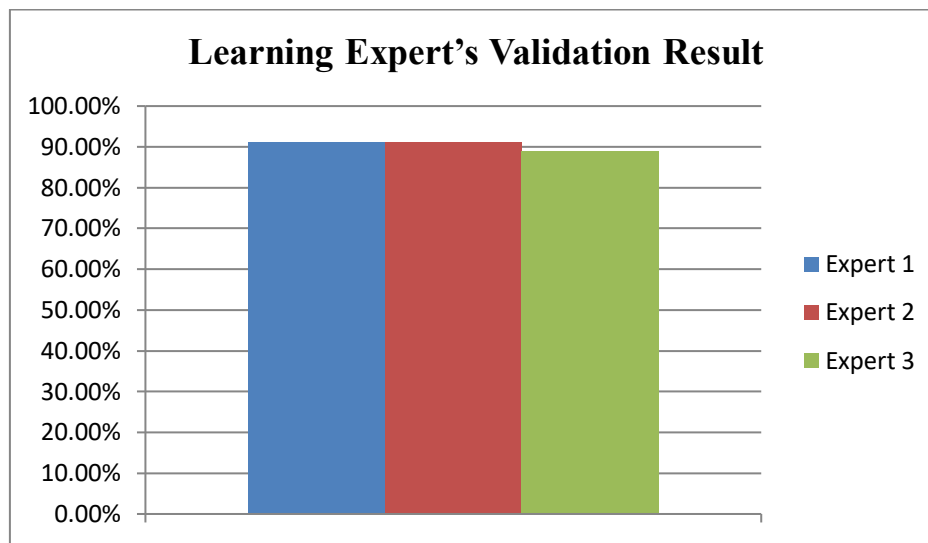


Figure 9. Learning Expert's Validation Result

Learning validation consists of nine indicators. Validation score by learning expert 1 is 91.11%, by expert 2 is 91.11% and by expert 3 is 95.56%. Average validation result obtained is 92.59%.

From this result can be concluded that development of cMOOCs based on multimedia on the thermodynamics subject has a very good result and can be implemented in thermodynamics learning.

From the result of pretest and posttest, N-gain was for class A was obtained by 0.75 (high) and class B by 0.34 (medium). According to Hake, Average N-gain was in medium category ($0.3 \geq g \geq 0.7$) [4].

Table 5. N-Gain Criteria [4]

N-Gain Score	Category
≥ 0.7	High
$0.7 > \text{N-gain} \geq 0.3$	Medium
< 0.3	Low

N-gain is normalization that obtained from pretest and posttest result [4]. N-gain calculation is used to find the improvement using web-based media before and after usage.

4.2 Documentation



Figure 10. Learning activity using cMOOCs at class A



Figure 11. Learning activity using cMOOCs at class B



Figure 12. Pre-test at Class A



Figure 13. Post-test at Class A



Figure 14. Pre-test at Class B



Figure 15. Post-test at Class B



Figure 16. Student accesses cMOOCs via smartphone

5. Conclusion

Expert material validation results showed 93.33% (very good). Media (e-learning) expert validation results showed 92.59% (very good). Learning validation results showed 92.59% (very good). This cMOOCs can increase students' self-directed learning outcomes, proved by N-gain result = 0.75 (high category) for class A and 0.34 (medium category) for class B. So, development of cMOOCs based on multimedia for the thermodynamics subject can improve students' self-directed learning outcomes.

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