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| RESEARCH ARTICLE

Developing Learning Management System-Based Inquiry Model Learning Devices for Dynamic Electricity Materials

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| ABSTRACT
This research is aimed at producing LMS-based inquiry model learning devices for dynamic electricity materials and probing the validity, effectiveness, and practicality of the developed products. This was research and development (R&D) using the 4D model made up of four phases, which were Define, Design, Develop, and Disseminate. The research subjects were twelfth graders in Science class SMAN 1 Bolangitan. Data were collected using several instruments: expert validation sheets, learning output tests, and student response questionnaires. The learning device validity was determined based on the mean score given by content, design, and learning media validators. The mean score was 1.00 at the very valid criterion. The N-gain, identified to observe the learning device effectiveness, was 0.77 at the effective criteria. The mean score of student responses was 70.06 at the very practical criterion. Building on the results, the developed devices met the criteria for quality products, i.e., valid, effective, and practical.

| KEYWORDS

Learning Management System, Inquiry, Dynamic Electricity

| ARTICLE INFORMATION

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1. Introduction

The millennium century (11th Century) marks knowledge development and the globalization era. Strict competition in education demands science and technology, and development. Quick changes in society's needs should be accompanied by escalated education quality, allowing graduates to be able to compete globally. Therefore, 21st-century learning emphasizes student capacity for critical thinking and bolsters student creativity and unlimited learning material literacy that moves forward than simply by studying learning materials provided by schools.

Ministry of Education and Culture Regulation Number 58/2014 concerning the 2013 Curriculum aims to create productive, creative, innovative, and affective Indonesian citizens through an integrated attitude, skill, and knowledge reinforcement. To realize the purpose, Ibrahim proposes the following principles: (1) student-centered, (2) cultivating student creativity, (3) creating a fun and challenging atmosphere, (4) containing values, ethics, aesthetics, logics, and kinesthetics, and (5) providing a fun, contextual, effective, efficient, and meaningful learning experience. The learning experience will grow, resulting in independent learning habits that are the base for lifelong learning.

Learning activities must be designed in such a way as to enable attitude, knowledge, and skill development using various combinations and emphases (Ibrahim, 2014). A learning device serves as the preparation made by teachers before giving learning activities. Simply speaking, a learning device is media facilitating and stimulating students to make decisions (Rahmawati et al., 2020). A learning device is a tool or instrument to carry out a process that helps teachers and students conduct teaching-learning activities. It makes the learning process more oriented and structured. Reliable learning devices in line with the science curriculum are inquiry-based and come in the forms of a syllabus, lesson plan, student worksheet, handout, and learning outcome test, which can improve student learning outcomes, covering knowledge and science process skills. Using developed learning devices, teachers can realize learning objectives by focusing on students' critical thinking skills.

One of the learning models that can increase students' critical thinking levels is inquiry, a learning model applicable in a class with students having various skills. Inquiry learning has some stages, namely orientation, problem formulation, hypothesis making, data collection, data analysis or hypothesis testing, and conclusion drawing. The inquiry learning model also boosts students to think and work grounded on their initiatives.

The inquiry learning model, according to Eggen in Sinuraya et al. (2012), is a learning model that can encourage students to study a problem and find evidence-based solutions. The inquiry method employs a syntax in learning: 1) Stimulation, 2) Problem statement, 3) Data collection, 4) Data processing, 5) Verification, and 6) Generalization. The inquiry model heightens student motivation to learn science, knowledge, and critical thinking skills. Its strength notwithstanding, the inquiry model possesses a weakness, that is, time limitation that can result in incomplete learning stages as the time is running out (Sinuraya et al., 2012). In other words, the time allocated is not proportional to the learning objectives that should be achieved. Thus, we need a quest to address the time restraints in physics study, promote technology skills, and scale up the conceptual understanding of dynamic electricity materials. The quest must be implementable using an online learning system.

This online learning system is referred to as e-learning. E-learning is one of the technology facilities acting as learning media allowing students to learn independently and act as the learning center (student-centered) (Purwaningsih et al., 2017). As a result of the advantages and efficiency of e-learning, a range of e-learning-based learning model innovations have arisen, one of which is the Learning Management System (LMS). Manegar (2012) posits that LMS is an application or software leveraged to manage online learning in terms of its materials, placement, management, and assessment. The learning design can develop student technology and information media-related competencies. Some LMSs that can be used in learning processes are Schoology, Learnboos, Edmodo, Moodle, and others. Among the LMSs, Moodle, the education issue that is growing more popular these days, is the most applicable in Indonesia. Moodle is one of the sites that can combine social networking with LMS. Moodle can facilitate video conferences, discussions, quizzes, and report assignments and assessments. In addition, it provides features advocating online learning. Using Moodle as a digital learning source can buoy learning implementation and scale up student learning outcomes, especially attributed to dynamic electricity learning in state senior high schools. Moodle is vastly used as it provides efficiency in learning processes for teachers and students. In a learning process using e-learning, students can collaborate, propose questions, and think critically. In this research, dynamic electricity learning at state senior high schools was performed by combining face-to-face with online learning. The type applied was online-face to face-online. We gave several inquiry process activities to the online class. Students were given a phenomenon and instructed to formulate the problem and hypothesis on the grounds of the phenomenon, design an experiment, and discuss it online. Meanwhile, during face-to-face learning, students were required to continue inquiry activities, in which they had to conduct an experiment, collect and analyze data, and draw a conclusion. Responding to the online learning system transition, teachers should be ready for various changes in teaching-learning patterns in reasonable agreement with learning and student conditions.

Predicated on the background, we are interested in performing research on "Developing Learning Management System-Based Inquiry Model Learning Devices for Dynamic Electricity Materials".

2. Methods

This development research used the 4D development model. Developed by Thiagarajan and Semmel in Trianto (2013), the 4D model was composed of four primary phases, i.e., Define, Design, Develop, and Disseminate.

In this research, we developed LMS Moodle-based inquiry model learning devices. The developed devices were targeted to physic materials, specifically the "Dynamic Electricity" theme. The research was undertaken for twelfth graders in Science class at a school in Bolaang Itang Barat Bolaang Mongondow Utara. The research was carried out in the odd semester of the academic year of 2022.

The data analysis technique used was the qualitative descriptive approach. Qualitative data (preliminary study data, expert test data, practicality test data, and effectiveness test data) were analyzed using the approach.

Through this analysis, we acquired the description of field needs, supporting facility availability, student perceptions of the internet, student experiences of studying physics, student perceptions of physics learning, device components needing revisions, and validity and practicality levels of learning devices.

Data on learning design and material compatibility of the products were collected from validity tests (content validity test, design expert test, and media expert test). The data on compatibility were used to identify product reliability levels. Data from the validity test questionnaire would exhibit suggestions for improvement we could use as references to refine these learning device products. Table 1 indicates the validity criteria.

Table 1. Validity Criteria

Coefficient of Validity	Criteria
0.91 – 1.00	Very valid
0.71 – 0.90	Valid
0.41 – 0.70	Acceptable
0.21 – 0.40	Invalid
0.00 – 0.20	Very invalid

(Tegeh &Kirna, 2010)

The device practicality analysis technique was used to identify student responses to the developed e-learning media.

To interpret the meaning and make decisions bearing on student responses to the developed e-learning based media, we used a Likert scale with five alternate answers. The scoring of these answers is listed in Table 2.

We found the mean of the assessment scores and converted them into assessment statements to determine the quality. Score conversion into quality statements is shown in Table 3.

Table 2. Option Scoring

Option	Option	Score
Very practical	Very good	5
Practical	Good	4
Acceptable	Acceptable	3
Less practical	Poor	2
Not practical	Very poor	1

(Sutanto & Sartinem, 2009)

Table 3. Quality Assessment Score Conversion

No.	Interval	Category
1	$67.5 \leq x$	Very positive
2	$52.50 \leq x < 67.5$	Positive
3	$37.50 \leq x < 52.50$	Negative

(Nurkanca & Sunarta, 1992)

The e-learning device effectiveness was observable in the pilot test results, pretest, and posttest given to identify increases in learning outcomes using Moodle e-learning media for dynamic electricity physics materials.

We used N-Gain, and the Gain was the increase in student competency after learning. The Gain was obtained from the difference between pretest and posttest results. Data were descriptively analyzed to identify increases in students' conceptual understanding after learning. There were three categories of normalized gain acquisition, as suggested in Table 4.

Table 4. Gain Criteria

Gain Index	Interpretation
$g > 0.70$	High
$0.30 < g < 0.70$	Medium
$g \leq 0.30$	Low

(Hake, 2002)

3. Result and Discussion

We made e-learning media products to study dynamic electricity for science twelfth graders at a school in Bolaang Itang Barat, Bolaang Mongondow Utara. This research used the 4D development model comprising four key phases, i.e., Define, Design, Develop, and Disseminate.

The following suggests the results we acquired in each phase.

3.1 Results from the Define Phase

The Define phase aimed to clarify the urgency of the issue being investigated. The phase included the developed learning media, an analysis of the Internet facility availability for students, and student experiences of learning physics, especially dynamic electricity materials. Data were collected through interviews to observe physics teacher needs, particularly the teacher teaching twelfth graders in Science class. A need analysis was carried out at the beginning of this research to find information that clarifies the research problem position (Arikunto, 2013). The interview results are demonstrated in Table 5.

Table 5. Recapitulated Interview Results

No.	Aspect	Problem Identification
1	Internet access	Students were permitted to use smartphones during learning to access information needed. Nevertheless, the technology was still poorly used to espouse learning processes.
2	Dynamic electricity learning	Dynamic electricity was a complex material and required a relatively long delivery time, bringing about time constraints. The method applied by the teacher was the same, namely giving exercises and experiments.
3	Learning media	The media the teacher used were books containing material summaries. As such, students rested on the teacher's explanation and had no adequate exercises.
4	Challenge	The time allocation provided did not support learning objective realization. Dynamic electricity was a complex material and required a relatively long delivery time.

Grounded on the need analysis conducted on the teacher and students, the results were supportive of blended learning device development, particularly Moodle-based learning management system learning or e-learning devices, to make students active and independent in learning.

These learning media, which could be accessed anywhere and anytime, enabled students to access learning materials more efficiently because they allowed

3.2 Results from the Design Phase

After finding the potencies and field problems, we made learning devices to elevate student independence and learning outcome. The learning model used was blended learning with web-based Moodle. The developed learning devices used blended learning as the learning model, which was a combination between face-to-face and online learning. The term commonly used in online learning is the Learning Management System (LMS).

The intended e-learning design was related to the inquiry-based mix learning design, which part was implemented online and which part was implemented offline, and the time division. To be more specific, the inquiry model e-learning design used was online learning-face to, face learning-online learning. The online learning class and content were designing a class and content that could facilitate students to learn online independently or collaboratively.

We designed the learning devices and media to be developed. The learning devices made covered a syllabus, lesson plan, student worksheet, learning outcome test, handout, and online class. The learning medium used was Moodle web set as a learning source and facility distributing teaching materials, exercises, and assignments to twelfth graders in Science class.

The results of this learning media development were Moddle web-based LMS media to learn dynamic electricity. The media were in the form of materials and videos accessible online.

The e-learning media were designed using the web-based Moodle platform. Learning using these media adhered to blended learning model stages implemented in learning activities. Each activity was divided into three main activities: online-face to, face-online. Figure 1 exhibits the three main activities or blended learning-type activities (Maharta et al., 2016).

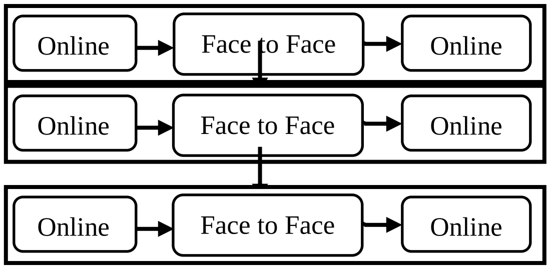

Figure 1. Blended Learning Design

We undertook inquiry phases in each activity indicated in Figure 1. Several inquiry activities were carried out in the online class. Students were provided with phenomena and asked to formulate problems and hypotheses pertaining to the phenomena, design experiments, and discuss the experiments online. Meanwhile, during the face-to-face class, students were instructed to continue inquiry activities. They conducted experiments, collected and analyzed data, and drew conclusions. The inquiry phases performed are shown in Figure 2.

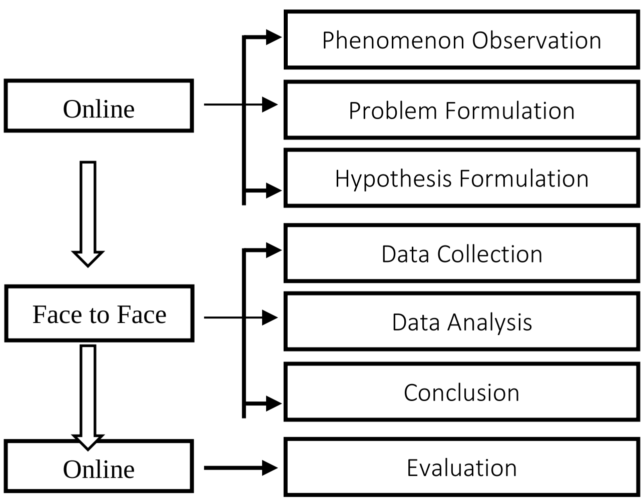

Figure 2. Inquiry Design

In blended learning implementation, some aspects should be considered, i.e., learning objective characteristics desired, relevant learning activities, and the determination of which activities were relevant to conventional learning and which ones were relevant to online learning (Prayitno, 2013).

3.3 Results from the Develop Phase

This phase consisted of two sub-phases, namely the learning content development result and e-learning Moodle media development result sub-phases. Learning content was developed by gathering learning materials from several book sources regarding dynamic electricity, typing learning materials, and designing materials and evaluation instruments pursuant to the expected basic competency.

All developed learning devices, learning media, and research instruments were validated by expert validators of learning devices, learning media, and research instruments. A validity test aimed to probe product design validity and learning device reliability for learning. Validators gave suggestions for improving learning devices, learning media, and research instruments we designed. We then applied the suggestions to improve our product designs. Validator suggestions served as materials enabling us to improve our product designs and eventually engender products ready to try out.

All products we made were tested on research subjects that were twelfth graders in Science 2 Class. The product test was conducted in three meetings: September 19th, 21st, and 22nd, 2018. Each meeting was held in hours 1-3 for 135 minutes. During the test implementation, we used Moodle to deliver dynamic electricity materials to twelfth graders in Science 2 Class as a medium to discuss and distribute materials, assignments, and quizzes and collect tasks and quizzes.

The products were revised on the grounds of suggestions predicated on the product test results. The suggestions became materials for revision. Product revision was undertaken to eradicate weaknesses that could compromise reliable product use. We revised to optimize the efficiency of the developed products, i.e., LMS Moodle-based learning device designs.

The results of learning media development to learn dynamic electricity were in the web form using the Moodle platform. Teachers, students, and parents could access Moodle-aided e-learning media. The three users were interrelated in the media.

The e-learning features were accessible once users had registered in Moodle. The users intended were students and the physics teacher teaching dynamic electricity to twelfth graders in Science 2 class. Users should log in first to access the e-learning media. Figure 3 shows the main page of the Moodle-aided e-learning media after being logged in.

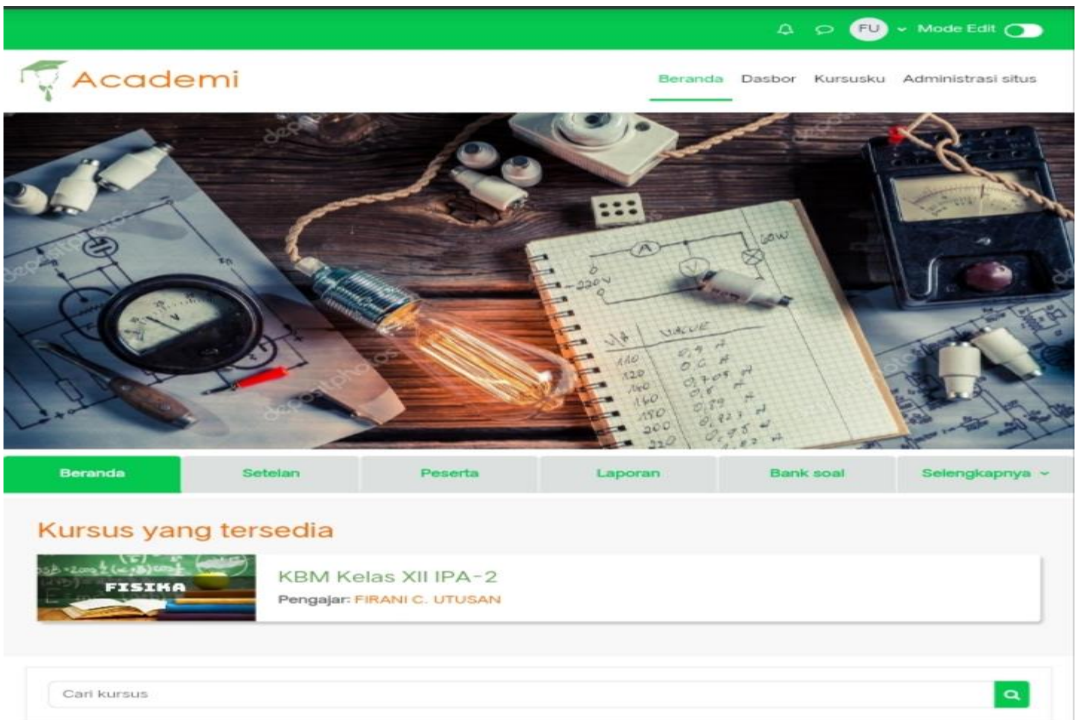

Figure 3. Main Page

In developing these Moodle-based e-learning media to learn dynamic electricity, students and the teacher acted as the users.

The teacher served as the user that gave learning activities, i.e., giving learning materials, tasks, and evaluation. The teacher registered in the Moodle-aided e-learning media was the teacher teaching physics for twelfth graders at Science 2 class SMA Negeri 1 Bolangitang.

Students acted as e-learning media users. They were directly engaged in the learning process and had access facilities of only reading and sending data through e-learning media. The learning activities were participating in the learning process by reading/watching learning materials, doing tasks, watching and downloading learning videos, participating in a discussion, participating in a learning evaluation test, and look student scores carefully.

In terms of interface, all users should pass this page to participate in all learning activities using Moodle-aided learning media. The login page for students and the teacher had the same interface. Users were requested to enter usernames and passwords to access e-learning media. Figure 4 indicates login development results.

The learning activity page contained learning activities in one semester (the odd semester) or in one certain material. Learning using the LMS Inquiry Learning Model had the following phases, namely introduction, stimulation (searching learning videos and learning modules for learning information), problem statement (identifying many different issues presented in a video on Moodle e-learning and choosing the most interesting and flexible one to solve), data collection (collecting data by reading literature associated with the material from textbooks or the internet), data processing (processing data individually or in the group to acquire the results in the form of student worksheets, verification (providing a discussion forum and student worksheets to verify data collected), generalization (students making conclusions and submitting assignments through Moodle or the Bigbluebutton discussion forum available in Moodle e-learning in all inquiry stages. Figure 5 shows the results of the learning activity page development.

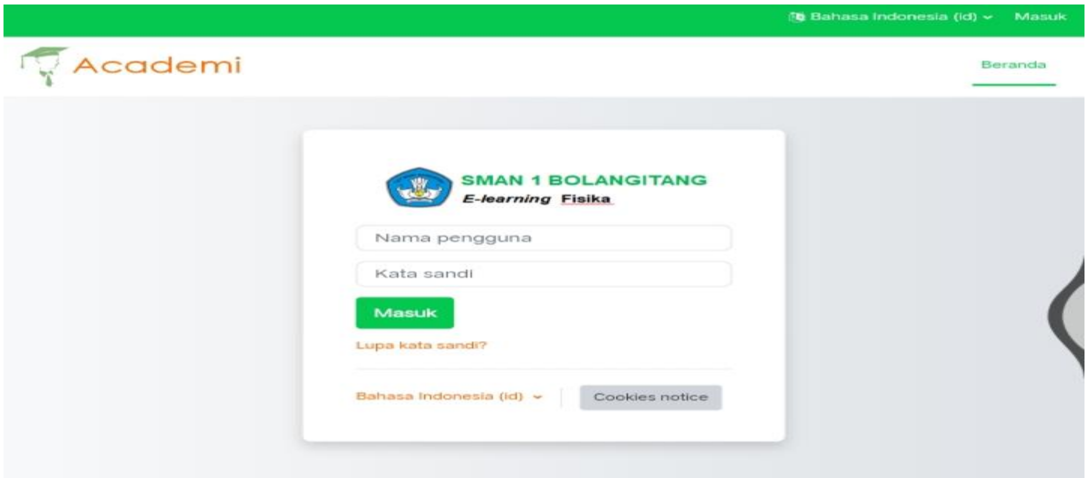

Figure 4. Login Page

Figure 5. Online Class Development Results in Moodle

In the validity test of e-learning media, the content validator gave a score of 1.00, stating that the media were "Very Valid". The media validator, using a media expert test questionnaire, gave the same score, also suggesting that the media were "Very Valid". The design validator, using a design expert test questionnaire, likewise gave a score of 1.00, demonstrating that the media were "Very Valid". Table 6 exhibits the mean score of the validity tests.

Table 6. Mean Scores of Validity Tests

Expert Validator	Result
Content expert	1.00
Design expert	1.00
Media expert	1.00
Mean score	1.00

Converted by referring to Table 1, the mean score showed that the media were "Very Valid". Accordingly, the e-learning media used to learn physics, particularly dynamic electricity, were reliable to use in the physics learning process.

The learning device effectiveness was identified using N-gain Normality. This normality test was carried out through a pretest and posttest to investigate increases in student learning outcomes after using e-learning media to study physics. The results of the student pretest and posttest are demonstrated in Figure 6.

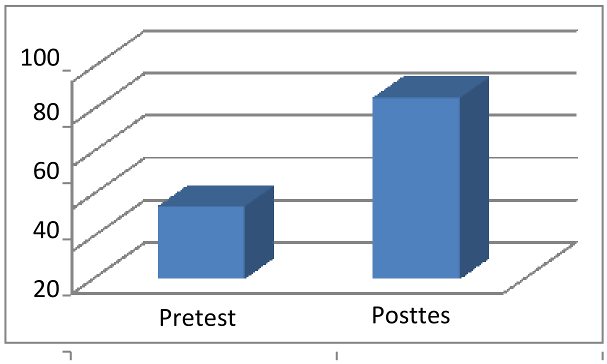

Figure 6. Pretest and Posttest Scores

Building on the pretest and posttest analysis results, the initial mean of 34 increased by 51.33 to 85.33. We analyzed the N-Gain or Normalized Gain to examine posttest score increase levels. The N-Gain was 0.77, giving the posttest score the "high" criterion. This categorization referred to the Normalized Gain Criteria Table by Hake (2002). Accordingly, our physic e-learning media could augment learning outcomes.

In the student response test, we distributed questionnaires to 15 twelfth graders in Science 2 class. They used e-learning media to study physics in the teaching-learning processes. The mean result was 70.66%, belonging to the "Very Positive" qualification with a "Very Practical" criterion. The qualification and criterion are referred to in Table 3.

It indicated the successful development of Moodle e-learning media to study physics. It was attested to by comments on questionnaires, e.g., student motivation and happiness when using Moodle e-learning media and student enthusiasm when learning using e-learning media.

4. Discussion

Developing Moodle e-learning media to study physics aimed to broaden learning sources and learning media. It was expected to elevate the understanding of physics during the learning processes in the class. Grounded on the results of preliminary observation at SMA Negeri 1 Bolangitang through interviews, students found difficulties in understanding the physics materials the teacher delivered, and the learning media used were modules for the teacher. Media used during the learning process were PowerPoint presentations. Additionally, students suggested their interest in participating in learning if, in material delivery, the teacher gave a link to access the materials and learning videos with an online discussion forum that students could use to express problems in the learning process. Using media allows them to access learning materials; students can access materials easily and anywhere, either at the school or their houses. As such, students needed a platform to access materials or discuss with the teacher or peers.

One of the solutions to solve the problems was designing learning media with learning models that could optimize the material delivery process. We could use technology in learning, such as web0based Moodle e-learning media. E-learning media could facilitate the teacher to deliver learning media to students. Using e-learning, students can access learning videos, audio, and materials, enabling them to understand learning materials better.

In this research, the e-learning media were designed using the blended learning model. The model could combine traditional (face-to-face) with online (e-learning) learning models. According to Bawaneh (2011), blended learning could augment student performance, attested to by an elevated number of students that were online when learning and discussing online. Mubaraq, in Hermawanto (2013), argued that web-based learning could cultivate student independence, allowing them to self-construct knowledge, demonstrated by enhanced conceptual understanding, escalated generic science, and good responsiveness. It was in conforming with Longo (2016) that students could collaborate, propose questions, and think critically when using well-planned blended learning.

We designed online and face-to-face learning. The designs complied with the blended learning inquiry model. The model referred to a scenario enabling students to independently choose their classes. These classes were online and acted as complementary to traditional ones. These classes were equipped with supervising teachers, i.e., online teachers (Dwiyogo, 2018). The blended learning model could be implemented online or face-to-face. Using e-learning inquiry learning media, students could carry out 1) stimulation: exploring materials to make the information acquired relevant to the addressed topic; 2) problem statement: identifying a variety of issues and then selected for the most interesting and flexible to solve; 3) data collection: collecting different, relevant information by reading accessible, online literature, 4) data processing: processing, classifying, and tabulating data. The data were then calculated using a particular method and interpreted at a given confidence level; 5) verification: drawing conclusions grounded on the results of discussions germane to experiment data gathered with groups; and 6) generalization: presenting experiment results. In this learning, we combined face-to-face and online learning. The type used was online-face-to-face-online. We gave several inquiry activities in the online class. Students were given a phenomenon and instructed to formulate problems and hypotheses in connection with the phenomenon and design an experiment and discuss it online. During face-to-face learning, students were asked to continue inquiry activities, namely experimenting, collecting and analyzing data, and drawing conclusions. Azizmalayeri et al. (2012) conveyed that the inquiry learning model could heighten scientific understanding, academic achievements, critical thinking skills, and prediction generating skills. Ergul et al. (2011) exhibited that learning using an inquiry learning model could improve students' process skills and conceptual understanding. It was in correspondence with Trianto (2009) that learning using an inquiry learning model highlighted how individuals think and how thinking influences how they process information.

On the grounds of the results of validation by content, design, and media experts, our e-learning media to learn physics, especially dynamic electricity, were valid/reliable and effective to be used as Moodle e-learning media for twelfth graders at science class SMA Negeri 1 Bolangitang. A pretest was given before students used the e-learning media, and a posttest was given after students used the Moodle e-learning media to learn physics, particularly dynamic electricity materials. These tests were given to identify increases in student learning outcomes after using the physics e-learning media.

The validity of the Moodle e-learning media was tested by content, media, and learning design experts, giving a mean score of 1.00, qualified as "Very High". Predicated on the result, our Moodle e-learning media to learn physics, specifically dynamic electricity, based on the content, learning design, and learning media, were valid/reliable to be used in learning processes. Sugiono (2010) proposed that product validity could be tested by some experts experienced in assessing product weaknesses and strengths, helping the products become reliable to use.

The effectiveness of the Moodle e-learning media was examined by giving a pretest and posttest to investigate increases in student learning outcomes after using the media. The N-Gain was 0.77, indicating that the increases belonged to the "Effective" criterion and that the media could promote student learning outcomes. Satrio (2008) remarked that effectiveness was an effect of the result of a policy or measure taken building on the desire to achieve the field target. From the pretest and posttest analysis, we acquire the mean percentage of student scores increases by 51.33. The initial mean was 34, and the latter one was then 85.33. We identified the N-Gain or Normalized Gain to identify the increased level of posttest results (Hake, 2002). The N-Gain generated was 0.77. therefore, the level was "High". Grounded on the result, our Moodle e-learning media to learn physics, especially dynamic electricity, could scale up student learning outcomes.

The following test was performed by taking student responses. The subjects were 15 twelfth graders in Science 2 class. They used Moodle e-learning media. The test resulted in a score of 70.06%. After the score was converted, referring to Table 2, the media were considered "Very Practical". Our Moodle-learning media were positively responded to. It indicated that the media made students understand physics and were accepted by both students and teachers as learning media.

Based on the student response test, our Moodle e-learning media were "Very Practical". The practicality test aimed to identify to what extent the media was efficient and implementable. Mudjijo (1995) remarked that practicality showed the level of use efficiency, implementation, and result processing and interpretation.

Building on the discussion and evaluation undertaken by content, learning design, and media experts, the developed Learning Management System (LMS)-based inquiry model learning devices fulfilled the product quality criteria, which were validity, effectiveness, and practicality. Accordingly, the products were reliable learning sources for twelfth graders in Science class SMA Negeri 1 Bolangitang. These Moodle e-learning media were expected to allow physics teachers to eradicate learning issues in relation to learning sources. Additionally, the media were also expected to enable students to efficiently interact with teachers or peers outside school hours and measure their competencies through tests or quizzes provided.

5. Conclusion

In conclusion, the Moodle e-learning media were reliable learning sources or media that could augment student learning outcomes. It was proven by the validation and student evaluation results at SMA Negeri 1 Bolangitang. The product development adhered to procedures and guidelines for developing learning devices. The products were valid based on the experts' validation.

In the development of Moodle-aided inquiry model e-learning media to learn physics, we did not carry out an individual test. We conducted a small group test to obtain teacher and student responses and measured student learning outcomes using limited measurement through a pre-test and posttest to identify the media effectiveness. As such, further research on the effectiveness of Moodle e-learning media is pivotal. Further researchers can also make innovations in Learning Management System (LMS) selection.

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