Moodle: A Research and Development of E-Learning Media During Pandemic Covid 19

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Abstract. The purpose of developing Moodle-based E-learning to assist teachers in teaching biology material with online learning. The current condition is that the teacher's skills in developing genetic material biology teaching materials are still lacking. Especially during the COVID-19 pandemic, there is a paradigm shift in learning from an offline environment to an online environment. In addition, the characteristics of genetic material are very difficult to teach, so it requires good media to solve the learning problems. Moodle is a web-based application that allows its users to organize educational content and has many convenient features to create various learning activities. This study aims to: 1) produce Moodle-based e-learning for the study of biological genetic material, 2) know the validity, practicality, and effectiveness of Moodle-based e-learning developed. This research and development refer to the ADDIE development model. The testing in this product consists of alpha test, beta test, and effectiveness test involving media experts, material experts, teachers, and students. Data collection using observations, interviews, assessment scales and tests. Data analysis techniques use qualitative descriptive data analysis techniques and quantitative data analysis techniques. This research succeeded in producing a Moodle product that has excellent quality from experts and a high level of effectiveness when used in biology learning.

Keywords: E-learning · Moodle · Genetics Materials

1 Introduction

Instructional Technology is the study and ethics of practice to facilitate learning and improve performance through the creation, use, and regulation of technological processes and resources [1]. Its role is very important in spurring and triggering learning and learning activities. The challenge of a learning technologist is the development of technology itself, how he can develop technology to facilitate learning. Learning concerns a relatively permanent change in one's knowledge and or behavior due to experience. However, learning is strongly influenced by internal and external factors in the process. So, to make effective, efficient, and fun learning requires proper analysis in designing the learning.

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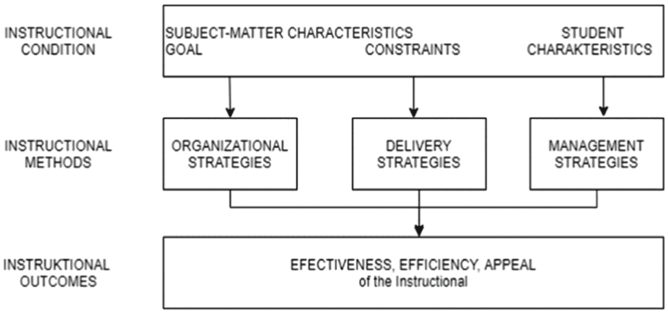

Fig. 1. Instructional Design according to Reigeluth (1983).

An important aspect of designing an effective, efficient, and interesting program is explained by Reigeluth (1983: 18–20) in his book instructional design: theory and model states that " there are three major components of a theory of instruction: methods, condition, and outcomes", which means there are three important components in instructional design theory that is by looking at aspects of methods, conditions, and results [2]. These three aspects are described in Fig. 1.

Based on Fig. 1 a learning technologist must analyze the initial conditions in the field to design a learning program according to the needs based on three important aspects, namely: material characteristics or objectives (subject matter characteristics), constraints (constrains), and student characteristics (student characteristics).

One of the challenges today is the covid-19 virus outbreak that requires the learning process that students initially come to school now must study at home. This is due to the government's policy on Work from Home (WFH). The government's policy is intended to prevent the spread of the covid-19 virus at a national time. One solution for WFH to run well is to use Internet facilities. The Internet is a globally connected computer networking system for connecting devices around the world. The Internet is a medium that can penetrate geographically, meaning users all over the world who are connected can obtain digital information effectively, efficiently, and easily. The Internet carries a variety of resources and information services, such as documents, email, telephone, music, photos, videos, and interconnected file sharing over the World Wide Web (www) network. Minister of communications and information Johnny Gerard Plate in (kominfo.go.id) stated that "during the covid-19 period the internet usage configuration shifted to housing, housing, and settlements. Therefore, all telecommunication service providers, especially the internet, are expected to be able to improve their quality" [3].

Internet usage in Indonesia is increasing, based on data from the Central Statistics Agency (BPS) it is known that from the population in Indonesia which reaches 266 million people, recorded 196 million internet users or about 73.3% of the population in Indonesia [4]. One form of utilization of information technology in learning through the internet is e-learning [5]. Suggests e-learning is "the use of various technological tools that are either Web-based, Web-distributed or Web capable for the purposes of education", which means the use of various web-based technology devices for educational purposes. Technology devices in the form of computers, smartphones, or other digital devices.

The concept of e-learning as a distance learning solution has been widely developed along with the development of the times and technology. There are many kinds of applications that allow for e-learning activities. One application that can be used is Moodle. Moodle is a web-based application that allows its users to organize educational content after a need or in a foreign language often termed with Learning Management System (LMS). Moodle allows teachers to assign assignments, upload lesson materials, make assessments, upload documents, online discussions, conduct video conferences in good quality [6].

There are many advantages to using Moodle-based e-learning media, including developing Moodle products for free educational products and being open source, meaning that they can be modified according to the needs of the user. Moodle also has strong community support, it is proven that Moodle has been used by 200 million users from 242 countries, 24 million courses have been created, and 2,396 million quiz questions, and supported by more than 120 foreign languages [7].

The features offered by the Moodle platform are also very supportive for direct (synchronous) and indirect (asynchronous) learning. So that it is possible to create various activities in learning. Some of the activities that can be done are Assignment, quizzes, chat, forums, surveys, polls, video conferences, workshops, accessing various forms of learning and multimedia content [8].

Judging from the material aspect, biology has specific material characteristics that are different from other fields of science. Biology examines living things, the environment, and the relationship between the two. Biological material is not only related to scientific facts about concrete natural phenomena, but also relates to abstract things or objects such as: chemical metabolic processes in the body, hormonal systems, coordination systems, etc. The properties of material objects studied in biology are very diverse, both reviewed from size (macroscopic, microscopic such as: bacteria, viruses, DNA), their affordability (polar ecosystems, deserts, tundra, etc.), their safety (pathological bacteria/viruses), language (the use of Latin in scientific names), etc. Thus, to design biological learning required a variety of supporting tools such as: the use of learning media, laboratory facilities [9].

Based on the results of the analysis of biology subject matter in 16 teachers from various schools and regions it was revealed that there are several subjects in biology that are difficult to teach by teachers because of media limitations. Based on the survey, teachers need learning media to teach biological material at class XII level which is quite difficult to teach with the following results about genetic material (37.5%), metabolism (31.25%), hereditary patterns (25%) and mutations (6.25%). Based on the data above known genetic material is a material that in the first order is difficult to teach so it is very important to develop learning media for the subject of genetic material. This result was reinforced by a survey of 22 high school students in grade XII in the same year in which students were told to choose two subjects that were difficult to learn. The result is genetic material (22.72%) and heredity 20.45%).

Reviewed from obstacles found in the field based on observations and interviews with biology teachers at SMA 1 BOPKRI Yogyakarta in 2020. The teacher said that for class XII level teachers have difficulty to teach biology on genetic material because of the limitations of learning media. Especially with the Covid-19 pandemic that requires

students to study independently at home. The teacher's previous habit was to use white-boards, LCD, and book packages provided by the school. While at the time of Covid-19 teachers rely on groups on WhatsApp and Google Classroom applications. In addition, the current condition is that the teacher's skills in developing genetic material biology teaching materials are still lacking. So currently teachers rely on textbooks to be used for self-study.

According to characteristics of students is done by looking at the students' theoretical thinking ability, motivation during the study of biology, student learning outcomes, and students' skills in using electronic devices. The background of Grade XII high school students is on average 17–18 years old, in theory adolescents whose cognitive development process has entered the formal operational stage. The main feature of development at this stage is that the child can think abstractly and logically by using a "possibility" thinking pattern. Scientific thinking models with hypothetico-deductive and inductive types have begun to have children, with the ability to draw conclusions, interpret and develop hypotheses [10].

The teacher also explained that during the study of genetic material, about 40% of students had to take remedial. This indicates that students have not achieved minimum completion criteria (KKM) in the subject of genetic material.

Students' skills in using electronic devices are good, this is in accordance with school policy before covid-19 when students study in the classroom, students are allowed to use smartphones for learning activities. In addition, during the covid-19 pandemic students have been used to learning online, so students are familiar with using e-learning.

Based on needs analysis, material analysis, student characteristics analysis, constraints, theoretical studies, as well as the current situation, namely the Covid-19 outbreak developers offer Moodle-based e-learning as a tool for biological learning. The learning process using Moodle-based e-learning media involves many directions where students can receive information not only from teachers but also from Moodle-based e-learning media. The presence of Moodle-based e-learning in online learning activities in the world of education will help the role of teachers or lecturers as facilitators. In this study, Moodle-based e-learning will be developed to assist teachers in the teaching and learning process about genetic material. Developers assume that developing Moodle-based e-learning media is one of the answers to the learning problems described briefly above. The formulation of problems in this study is:

1. How to produce Moodle-based e-learning in biology learning of genetic material class XII at SMA 1 BOPKARI Yogyakarta?
2. How is the validity, practicality, and effectiveness of Moodle-based e-learning in the study of biological genetic material class XII at SMA 1 BOPKARI Yogyakarta?

2 Methods

The research model used in this research is Research and Development, which aims to develop effective and efficient learning products for use in schools. In the development process refers to the ADDIE model consisting of 5 stages, namely: analysis, design, development, implementation, and evaluation. The ADDIE model is used to describe

a systematic approach to instructional development. ADDIE describes the stages of systematic, effective development design, and each stage can be revised before going to the next stage [11]. The research procedure in the ADDIE model is described in detail as follows:

1. The analysis stage consists of needs analysis, student characteristics analysis, and content/material analysis.
2. The design stage consists of preparation of material content, determining learning experience, flowchart creation, and instrument preparation.
3. The development stage consists of: Moodle-based e-learning production, and validation (alpha testing)
4. Implementation stage, conduct beta testing in small groups and large groups, and conduct effectiveness tests. The application of the product was conducted at SMA 1 BOPKRI Yogyakarta.
5. Evaluation stage is the evaluation stage is the process to analyze the results of implementation as a material for improvement of Moodle-based e-learning products, so that it can be known parts of the learning media that are not yet appropriate for students as users.

Product trial design is alpha testing, beta testing, and effectiveness test. Alpha testing consists of 1 material expert and 1 media expert. Beta testing is a small group (1 teacher and 5 students), and a large group (31 students). Test the effectiveness of the product by using pretest and posttest to measure students' cognitive knowledge of teaching materials. The results were then tested using an n-gain score.

Data collection techniques consist of interviews, observations, tests, and questionnaires by material experts, media experts, user responses (teachers and students). The data collection instrument consists of interview guidelines, material expert validity questionnaires, media expert validity polls, practicality questionnaires by teachers, practicality questionnaires by students, and multiple-choice question tests with a total of 25 questions. Data analysis techniques consist of assessment of validity, and practicality of products using the Likert type scale [12] and N-gain score analysis [13].

3 Result

The results of the study consisted of four parts, namely Moodle-based e-learning products, product validity, product practicality, and product effectiveness. Here are the results of this research.

A. *Moodle-based e-learning production*

The initial stage in the creation of Moodle is by building an e-learning portal using Moodle LMS. Moodle creation is done through web hosting and Moodle version used in this study is Moodle 3.7. The website address for Moodle-based e-learning can be accessed via browser in desktop or smartphone. The next stage is to include teaching materials into Moodle-based e-learning. The teaching materials are in the form of

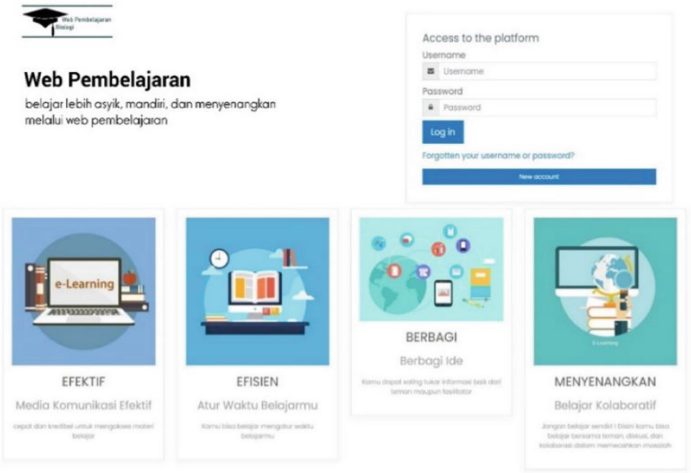

Fig. 2. Moodle Home Page View

learning modules, questions, learning videos, and hyperlinks (containing enrichment materials), as well as uploading a database of students that will be used as usernames and passwords.

The following are the results of Moodle-based e-learning product development for genetics learning:

1. Moodle page view

The introductory page is designed to match the characteristics and materials taught to students. The introductory page is created by combining text, images and buttons to get to the main page. On the start page there is also a login menu for students. Students get username and password from the developer (Fig. 2).

2. Course page view

Course page for genetic material becomes a source for students to obtain information on the material being studied. The course page also provides information about learning activity assessments, how to assess, and downloadable reference sources (Fig. 3).

3. Moodle introduction page view

On this page there is a video created by the developer to introduce the menu features in Moodle (Fig. 4).

4. Display of material teaching materials

The teaching language of the material first displays the mind map, then followed by an introduction to the material, and other menus such as (video conference menu, teaching material download menu (module), discussion menu, and quiz) (Fig. 5).

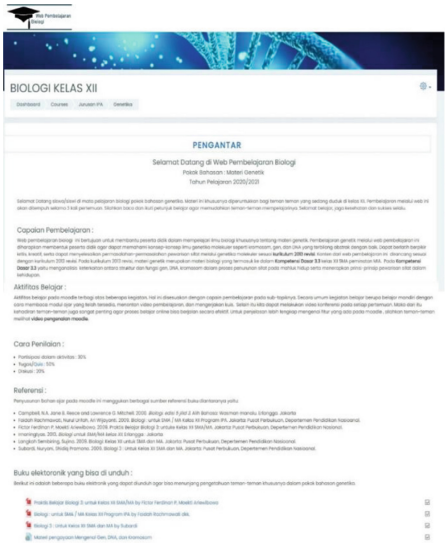

Fig. 3. Introductory Page on Moodle Courses

Fig. 4. Moodle Introduction Page View

5. Assessment view of learning outcomes

Tests are used to measure students' early and final abilities during Moodle use (Fig. 6). It becomes a reference to see the effectiveness of Moodle-based e-learning. The assessment page looks like the following image (Fig. 7).

6. Discussion forum view

To support the collaborative learning process is provided a discussion forum that can later be used by teachers and students when they want to discuss the material being studied (Fig. 8). The display of the discussion forum can be seen as shown (Fig. 9).

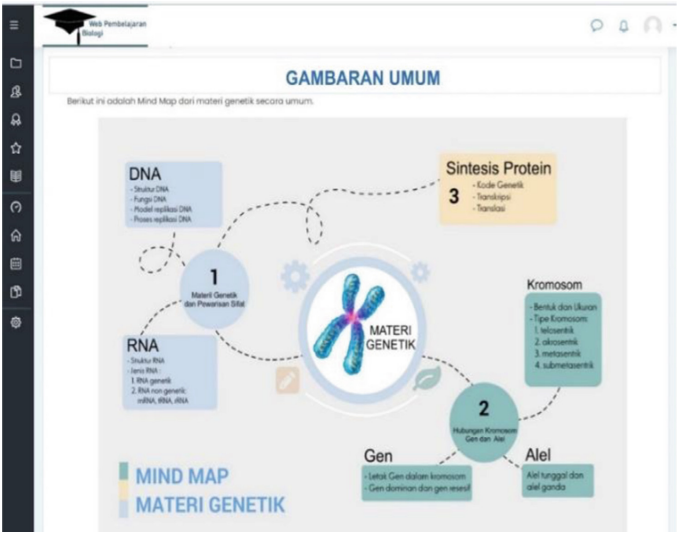

Fig. 5. Teaching Materials Page View with Mind-map

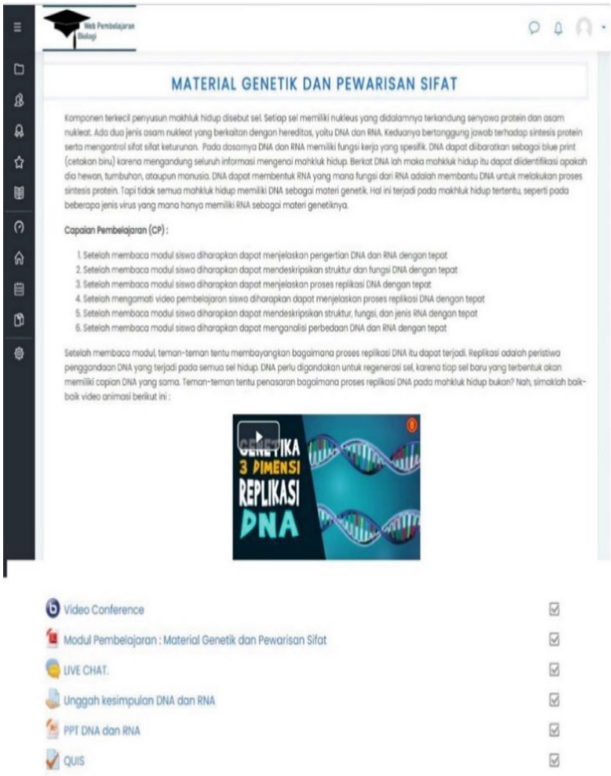

Fig. 6. Materials Display

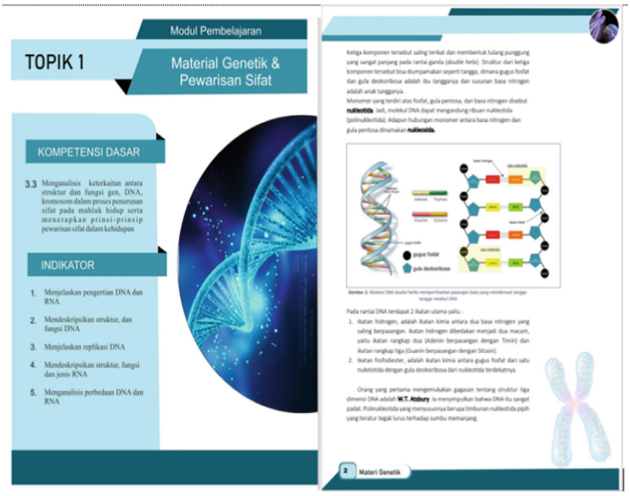

Fig. 7. Biology Learning Module View

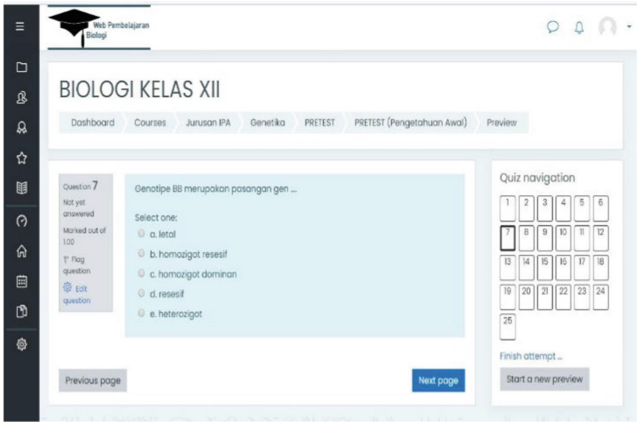

Fig. 8. Quiz Page View

7. Video conferencing

This menu serves for online learning activities. On this menu teachers and students can do face-to-face virtually (Fig. 10).

B. *Alpha Testing Results (Validity)*

Alpha testing is done in the third stage in the ADDIE model which is the development stage. Moodle-based e-learning media that has been developed and then validated by material experts and media experts using instruments that have been designed and validated also before. Validation of materials is carried out by lecturers of the Department of Biology, State University of Yogyakarta, namely Mrs. Dr. Ixora Sartika Mercuriani,

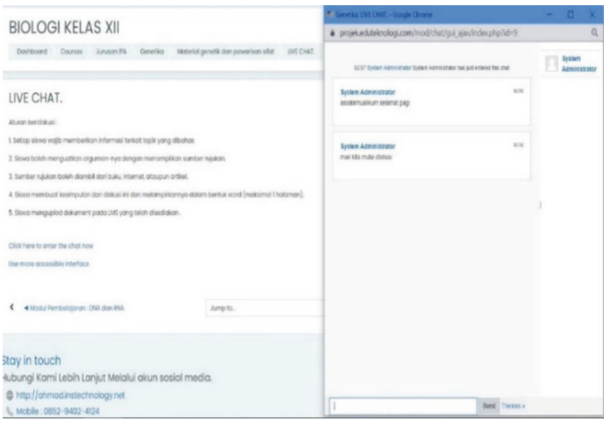

Fig. 9. Chat/Forum Menu View

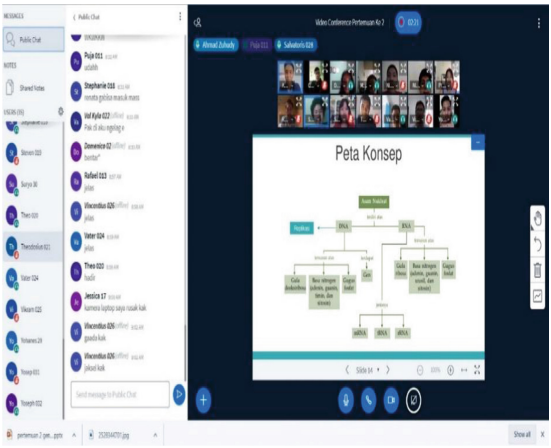

Fig. 10. Video Conference Menu View

M.Si. Material validation is done to assess the validity of materials in the development of biological teaching materials, generally assess the suitability of the material with basic competencies and indicators of learning achievements, as well as material usefulness. Validation of media experts was silenced by lecturers of the Department of Learning Technology, Yogyakarta State University, namely Mr. Dr. Pujiriyanto, M.Pd. Media validation is done to measure the validity of Moodle-based e-learning that is reviewed from the aspects of graphing and programming.

The results can be shown in the following (Table 1).

C. *Beta Testing results (Practicality)*

Moodle-based e-learning development products that have been validated by experts and revised according to the advice then then in the trial to teachers and students to know

Table 1. ALPHA TESTING ASSESSMENT RESULTS

Valuation	**Assessment Aspects**	**Score valuation**	**Category Validity**
Material Experts	Material Aspects	4, 60	Very High
	Presentation Aspects	4, 20	Hight
	Language Aspects	4, 57	Very High
	Average Score	**4,46**	**Very High**
Media Experts	Aspects Graphing	4,18	Hight
	Programming aspects	4, 10	Hight
	Average Score	**4,14**	**Hight**

the practicality of the product. The trials were conducted in two stages, namely small group trials and large group trials. Small group trial consists of one biology teacher and five students of class XII, large group trial consists of 31 students of grade XII. Teachers and students responded to Moodle-based e-learning development products both in terms of materials and media use. Here are the results of data analysis on small group and large group trials: (Table 2).

D. *Effectiveness Test*

Effectiveness tests were conducted in this study to measure the effectivity Moodle-based e-learning development products by looking at the results of improved knowledge of basic competency materials about genetic material. The test subject was class XII IPA 1 which consisted of 31 students. Effectiveness tests are conducted through pretest and posttest during 4 meetings. The first meeting was given a pretest question to measure students' initial knowledge in understanding basic genetic competency materials before using Moodle-based e-learning development products. The second meeting was conducted the learning process using Moodle-based e-learning that has been developed, this process lasts until the fourth meeting. The last meeting of the students was given a posttest question to measure the extent of the increase in students' knowledge of genetic material after following the learning using Moodle-based e-learning development products.

The results of the analysis of the comparison of pretest and posttest scores of students before and after using Moodle-based e-learning development products based on Table 3. Can be with the calculation of Gain Score as follows:

$$g = \frac{S\,Post - S\,\mathrm{Pre}}{S\,Max - S\,\mathrm{Pre}}$$

$$g = \frac{86,58 - 57,03}{96 - 57,03}$$

$$g = \frac{29,55}{38,97} = 0,75$$

Table 2. BETA TESTING ASSESSMENT RESULTS

Valuation	Assessment Aspects	Score valuation	Category Score
Small Group	Assessment by Teacher		
	Learning Aspects	4, 33	Excellent
	Aspects of Visual Communication	4, 30	Excellent
	Average Score	**4,32**	**Excellent**
	Rating by students (5 persons)		
	Practicality	**4,32**	**Excellent**
Large Group	Rating by students (31 persons)		
	Practicality	**4,40**	**Excellent**

Table 3. MOODLE-BASED E-LEARNING EFFECTIVENESS TRIAL RESULTS

No.	Variable	Score valuation	
		Pretest	***Posttest***
1	Lowest Value	36	80
2	Highest Score	76	96
3	Average	57,03	86,58
	Gain Score	**0, 75**	
	Gain Criteria	**Hight**	

N-Gain scores results showed there was an improvement in students' knowledge learning outcomes before and after using Moodle development products, as evidenced by the increase in student pretest and posttest scores. The researchers' conclusion from the results of the value analysis obtained that Moodle-based e-learning development products have a high level of effectiveness to improve students' knowledge about genetic material for grade XII students at SMA 1 BOPKRI Yogyakarta. Easy for them to find additional information for learning. Based on the survey results, it is known that 96.2% or 50 students agree and strongly agree to use a smartphone for learning activities. The use of smartphones in some schools is also permitted for learning activities.

4 Discussion

The development of Moodle-based e-learning for e-learning facilities in the study of biological genetic material for class XII SMA 1 BOPKRI Yogyakarta starts from the analysis to evaluation stage. The analysis stage is done by looking at the conditions in the field such as material analysis, obstacle analysis, and analysis of student characteristics.

Analysis is essential for designing Moodle-based e-learning that is effective, efficient, and fun. In addition, with analysis developers can consider the selection of the right learning media. Developers need to consider the quality of learning media both from the media side itself and from the user side, both for students and teachers who do the learning process [14].

After doing the next analysis and design the developer created Moodle-based e-learning. Moodle is an open-source software that supports the implementation of e-learning with an integrated paradigm and various learning support features can easily be accommodated in one e-learning portal containing various learning objects enriched with multimedia and combined with academic information systems, collections of teaching materials placed on the web, communication evaluation, discussion, and various other educational tolls [15].

Moodle was developed by utilizing one of the paid webhosting with online Moodle installation facility that is Niagahoster. To be able to use the available features, the developer must register first. Teaching materials uploaded as content is genetic material contained in the class XII in high school/MA. Teaching materials from Moodle-based e-learning are developed based on print books and electronic books at the high school/MA level to the University and based on advice and input from material experts. Validation results from material experts obtained an average score of 4.46 which means it has a very high validity. Moodle-based e-learning development also gets a lot of advice and input from media experts. After making improvements to Moodle-based e-learning obtained product assessment results from media experts with an average score of 4.14 which means it has a high validity. So based on these results Moodle-based e-learning products are ready to be tested.

Moodle-based e-learning trials are conducted involving the participation of teachers and students. After introducing Moodle-based e-learning teachers and students are asked to use Moodle for biology learning and will be asked for comments, suggestions, impressions, and assessments of Moodle products. In small-scale trials, the score from teachers was 4.32 with a very good category. Based on these results, the teacher assessed that Moodle is very well used for biological learning about genetic material both in the learning aspect and in information packaging.

The response of students in small and large-scale trials of 4.32 and 4.40 were both in the excellent category. The data shows that the presence of Moodle-based e-learning for students is excellent. Both in terms of teaching materials provided Moodle, as well as in student learning activities such as accessing learning content, watching learning videos, conducting online discussions through video conferences, and evaluating student learning outcomes. Moodle media containing materials, sample questions, animations that correspond to materials, activities, resources, forums, quizzes, and assignments have effectiveness in improving the quality of learning that is more interesting and controlled [16]. Presentation of material with Moodle media can provide high appeal to students. Students also responded well to learning media in the form of Moodle [17].

The effectiveness of Moodle use also has a high impact on students' learning outcomes on genetic material. Based on the data test the effectiveness of student learning outcomes before and after using Moodle-based e-learning falls into the high category according to the analysis of N-Gain scores. The N-gain score is 0.75. From these results,

Moodle proved effective as a medium of biological learning on genetic material for class XII at SMA 1 BOPKRI Yogyakarta. Improved student cognitive learning outcomes can occur because students enjoy learning using Moodle. The results of research by Riandi by floating LMS scientifically proven can improve motivation and student learning outcomes. This is shown by students enthusiastically in using various features in the Moodle such as learning videos, electronic modules, quizzes, and video conferencing [18].

The teaching materials compiled in Moodle have also been very good this is indicated by the expert assessment score of the material with a very high degree of validity. Research by Setiawan shows that good learning materials and design have a significant impact on students' learning outcomes [19]. According to Crowe, Dirks, & Wenderoth conducting analysis of teaching materials gives a good effect on the mastery of materials by students, students are also skilled in thinking high levels. In addition, the analysis of the material helps teachers in designing learning that can train students' cognitive skills [20].

Moodle as an innovation in distance learning is very helpful teaching and learning process, especially during the covid-19 pandemic situation that touches the distance or social distancing. The existence of this application makes it easy for facilitators and students to continue learning normally. Moreover, with various features such as quizzes, collaboration, assignments, and communication and who can upload various forms of material provided to motivate and improve student learning outcomes significantly [21].

5 Conclusion

The results of research and development of Moodle-based e-learning for biology learning of genetic material for class XII can be concluded that Moodle was developed using the ADDIE model which consists of five stages, namely: analysis, design, development, implementation, and evaluation. The resulting product is implemented for class XII students at SMA 1 BOPKRI Yogyakarta to improve student learning outcomes on genetic material. The result of product development is a Moodle-based e-learning portal. This product can be accessed through electronic devices such as computers/laptops, smartphones, or tablets.

The result of the product validity test based on the material expert got a score 4.46 with the "very high validity" category, while based on the media expert it is 4.14 with the "high validity" category. The results of the product practicality test based on user responses from the teacher got a score 4.32 with the "very good" category. While the responses of students' user responses in the small and large groups the score are 4.32 and 4.40. Both are in the "very good" category. Based on the results of these tests, it is known that this Moodle-based e-learning product is very well used in learning genetic material biology to improve students' cognitive learning outcomes.

This Moodle-based e-learning product is proven to be effective in improving student learning outcomes at the cognitive level after the pretest and posttest. The results of the N-gain analysis on the average score of pretests (57.03) and posttest (86.58) are in the "high" category, so this Moodle-based e-learning media can improve student learning outcomes at the cognitive level on genetic material.

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