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Developing gamification based biology learning materials for senior high school students in industrial agricultural area in jember, indonesia

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Abstract. This research aimed at describing the feasibility of gamification-based biology learning materials for senior high school students in the industrial agricultural area in Jember, Indonesia. The feasibility was based on the content validity, construct validity, and student responses. The development procedure of the learning materials used Plomp's development model which consisted of the preliminary investigation - design - realization - test, evaluation, and revision – implementation stages. The learning materials developed in this research were the syllabus and lesson plans, material modules, gamification modules. The research data were collected using interviews, observation, tests, questionnaires and documentation. The feasibility of the developed learning materials obtained very feasible criteria based on the average score by the expert team. Therefore, it can be concluded that the learning materials developed in this research are very feasible to be implemented in schools viewed from the content validity, construct validity, and student responses.

1. Introduction

Education is considered to have a role to support positive changes in society. This also relates to the role of educators as learning designers and the ones who carry out the learning process [1]. Providing feedback during the learning process is also essential [2]. Innovation in the learning process is important to do. This is related to the students' learning motivation. It is essential to raise students' motivation in every learning activity. This is related to the readiness of students in learning. Motivation can come from the external or internal factors of the students. Students with high motivation will be more enthusiastic in participating in the learning process and more responsible for their learning. Therefore, a true learning process requires not only students attending the classrooms but also students' active participation to take responsibility for their own learning. This can be observed from the students' active participation during the learning process [3].

The students' learning activities can be used to control their learning process and to measure how much they have learned [4]. In this research, it was stated that there is a positive correlation between students' metacognition and motivation [5]. It is further explained that with good metacognitive skills, a student will be able to manifest his learning in his behavior, and he will be able to take control over the learning process. Several external and internal factors may influence students' learning behavior. The external factors are such as barriers to learning, required resources, competition, etc., while the internal factors are such as students' ability, willingness to learn, and intention etc. [5].



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The implementation of online Biology learning nowadays has not been well structured, especially in the era of the Covid-19 pandemic. This is supported with the results of the classroom observations and the interviews with subject teachers. Most teachers were not accustomed to and did not know what to do in online learning, so that they only used one learning method for the online learning activities and less innovative. Teachers intentionally or unintentionally will learn about his profession through a process of interaction, experimentation, consultation, reflection, problem-solving processes and observations of conditions at school and outside of school [6].

Biology learning is often associated with rote memorization, but in fact it should not be. Various studies have been conducted as an effort to make students learn starting from experimental research, action research, up to a correlational research. Efforts are continually made to equip the students with the skills to anticipate the direction of change that will occur. These efforts include approaches to activate students both physically and mentally in science learning, to link the learning materials with the application in everyday life, or efforts to concrete objects of discussion, to train science process skills, and to involve students in problem solving [7]. This proves that biology learning is not only related to memorizing learning materials but also related to the concepts in everyday life. Learning is a process that involves the whole person, both physically and mentally [8]. Teachers have the responsibility to provide a meaningful learning process that is related to the real-life problems. Teachers should quickly acquire new knowledge and skills in order to provide effective learning process in the classroom [9].

Jember, a regency located in East Java, Indonesia, is an industrial area which is based on agricultural commodities, such as “*tape and suwar-suwir*” industries which use cassava as the raw material for production; coconut water drink business units that utilize coconuts as the raw material; the rice milling unit industry which utilizes rice as the raw material and the corn seed manufacturing industry (such as Sygenta and JHS) which utilizes corn as the raw material for its production [10]. The condition of the Jember Regency Agroindustry until 2013 as recorded in the Jember Regency Industry and Trade Service shows that the rice industry grew well with a production capacity of 3,800 tons per month. The rice industry in Jember Regency could absorb only 4.63% of the rice produced by farmers each month. The cassava-based industry in Jember Regency is dominated by the *tape*-making industry followed by the chips industry, *samiler* industry (chips made from cassava) and other industries [10]. The concept of industrial agriculture in Jember will develop better when these problems are brought up in the world of education as one of the topics associated with learning material. Biology learning is one of the subjects that can accommodate this. The researchers attempt to design an up-to-date learning because it is related to science and technology that is suitable to be applied during online learning, namely the gamification-based biology learning. In relation to the characteristics of Jember area, the researchers attempted to develop learning materials suitable for industrial agricultural areas.

2. Research Methods

The development of the learning model in this research referred to the stages of the Plomp development model [11]. The development stages in this research include preliminary investigation - design - realization - test, evaluation, and revision - implementation. Figure 1 shows a diagram of the Plomp development model. At the Plomp development model, the implementation stage is carried out in the form of a self-evaluation through a small group trial.

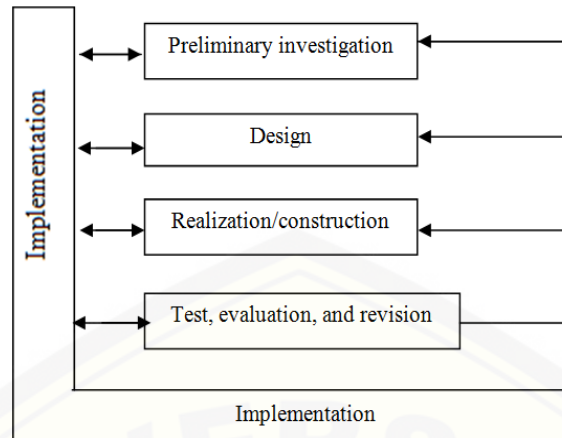


Figure 1. Stages of Plomp development model (1997)

The data in this research were collected using observation, interviews, questionnaires, documentation, and tests. The data analyses included:

2.1. Feasibility analysis of the learning materials

The feasibility analysis technique of the learning materials includes the syllabus, lesson plans, Gamification Modul , Learning Material Module. The feasibility of the learning materials is viewed from the content and construct. To describe the quality of the learning materials, it can be calculated using the formula according to Apriyanti [12] as follows:

$$\text{Score} = \frac{\text{Total Score obtained}}{\text{Sum total Score}} \times 4$$

2.2. Analysis of students' responses

Students' responses are the responses the students gave after they used the learning materials. The students' responses can be calculated using the formula according to Indiani [13] as follows:

$$\text{Score} = \frac{\text{Total Score}}{\text{The number of Question}}$$

Based on these calculations, to determine the criteria for student responses towards the learning materials can be seen in table 1 as follows:

Table 1 . Score Modification of Student Responses

No.	Score	Score Interval	Criteria
1.	4	3,50-4,00	Excellent
2.	3	2,50-3,40	Good
3.	2	1,50-2,40	Sufficient
4.	1	1,00-1,40	Poor

2.3. Analysis of the implementation of learning, analysis of student activities, student character values

The data obtained from the implementation of learning, student activities, and student character values were analyzed descriptively and quantitatively. Based on the scores obtained, the results of the analysis are described to obtain the quality of the numbers. It can be calculated using the formula following Supartin [14] as follows:

$$\text{Score} = \frac{\text{Total score}}{\text{Total of maximal score}} \times 100$$

Based on these calculations, to determine the criteria, it can be seen in table 2 as follows:

Table 2 . Score Modification of the Implementation of learning

No.	Percentage of Score Interval	Criteria
1.	$p \geq 85\%$	Excellent
2.	$70\% \leq p < 85\%$	Good
3.	$50\% \leq p < 70\%$	Sufficient
4.	$p \leq 50\%$	Poor

$$\text{Learning completeness (\%)} = \frac{\text{Total number of students who completed the learning}}{\text{Total number of students}} \times 100\%$$

Based on these calculations, to determine the criteria for student learning results can be seen in table 3 as follows:

Table 3. Score Modification of the Completeness Criteria

No.	Percentage of score interval	Criteria
1.	80-100%	Excellent
2.	70-79%	Good
3.	60-69%	Sufficient
4.	0-59%	Poor

3. Results and Discussion

The results of this research show a validation performed by content and construct validators. The validators were experts in their field. The results of the content validation on the syllabus and lesson plan obtained an average score of 3.84, and it was categorized as very good criteria. Based on the results of the content validation, the syllabus and the lesson plan are suitable with the gamification - based biology learning materials which are typical for students in industrial agricultural environments. This is based on the criteria of hard work, mutual cooperation and on target. In addition, the stages of the learning model are in accordance with the principle of gamification. The suitability of the basic competencies, indicators and learning objectives obtained a score of 4 with very good criteria. The learning objectives are in accordance with the aspects of Audience, Behavior, Condition, Degree (ABCD). Teachers have the obligation to develop learning materials for their teaching activities. Innovation in learning should be adjusted to the 21st century learning advances, because the 21st century is not a choice, but a responsibility that educators have to teach their students according to their era [15].

The content validation of the gamification module obtained an average score of 3.92 with very good criteria. This indicates that the format of the modules increases students' interest to learn, encourages students to learn, increases students' curiosity and responsibility, gives students challenges to solve problems in accordance with the gamification-based biology learning materials. In addition to developing a gamification module, this research also developed a module for the learning material. The results of the content validation of the module for the learning material obtained an average score of 3.86 with very good criteria. The content of the module is relatively short and specific, which is arranged to achieve the learning objectives. Moreover, a module is one of the teaching materials that has the principle of independent learning [16]. Some of the advantages of learning using modules are that modules can provide feedback, modules are arranged based on specific learning objectives, so that the content of the modules is more focused, modules which are attractively designed will certainly make it for students to learn. Nevertheless, the disadvantages of learning using modules are that the interaction between teachers and students is minimum, the single approach seems monotonous and boring, too much independence makes students less disciplined [17].

The results of the construct validation by experts on the syllabus and lesson plans obtained an average score of 4 with very good criteria. This shows that the learning materials contain complete information about the educational units, classes, semesters, subjects, time allocation, standard competence, basic competence, indicators, learning objectives, formulation of objectives in accordance with the aspects of Audience, Behavior, Condition, Degree (ABCD), presenting clear opening, main, and closing activities, learning activities in accordance with the structure and the order of the learning materials, suitable time allocation for the opening, main, and closing activities, the scenario for using the Material Module and Gamification Module in the lesson plan, the assessment type, the assessment technique, and the assessment instruments are in suitable with the learning indicators, the use of good sentence structure, and good word choice, the sentences in the syllabus and in the lesson plans are not ambiguous.

The lesson plans can be formulated well by involving several components, including the identity of subjects, core competencies, basic competencies, learning indicators, learning objectives, teaching materials, time allocation, learning approach or learning model, learning stages, assessment technique, and learning resources. The results of the construct validation by experts on the syllabus and the lesson plan obtained an average score of 3.84 with very good criteria. Permendikbud Number 65 of 2013 concerning process standards explains that the lesson plan is the description of the syllabus to direct student learning activities in an effort to achieve the basic competencies. Teachers in the classrooms are required to make a complete lesson plan, so that the learning activities can be interactive, inspiring, fun, challenging, and motivating to students. As a result, the students can actively participate in the learning activities. In addition, the lesson plan should also use a good language structure in order to attract students' interest.

Moreover, the results of the construct validation by experts on the Gamification Module and the Material Module obtained an average score of 3.92 and 3.86 respectively with very good criteria and feasible to be implemented. This indicates that both the gamification module and the material module use good and complete sentence structure, proper and correct vocabulary, interrogative sentences for the formulation of the problems, clear images, and good book design which can attract students' interest. The gamification module is a module that presents the steps for the implementation of learning using gamification principles. Learning is based on the current technological developments. Although integrating ICT in Education is still a big challenge nowadays, conceptualizing IT-based learning will be an extremely interesting learning approach for students [18].

The completeness of the implementation of learning obtained an average score of 3,72 with a percentage of 93 % with very good criteria. This is in alignment with the statement by Sugiantara that learning will be able to successfully implemented y teachers and students if the steps are easy to follow [19]. Yuliana states that the implementation of learning is said to be very good when it obtains a percentage of $\geq 85\%$ [20]. The assessment of the learning processes and the learning results shows that teachers monitor student learning progress during the learning process and make assessments according to the expected competency (learning objectives) [21]. Regarding the learning process, it is explained that the learning phenomenon is like a teacher as an artist because teachers should have the ability to improvise and innovate, and a teacher as a researcher because teachers have an obligation to evaluate the learning process through research [15]. It is further explained that in a learning process the teacher requires the involvement of knowledge and the open-mindedness to accept and follow changes, considering that a professional and responsible teacher should be able to listen and accept all criticisms for the betterment of the learning process in the future.

4. Conclusion

The results of the validation test on the gamification-based biology learning materials obtained an average score of 3.80 with very feasible criteria. The results of the validation based on the content validation, construct validation, and language validation tests as a whole on the syllabus and the lesson plans obtained a score of 3.84 (very good criteria), the Gamification Module obtained a score of 3.92 (very good criteria), and the Material Module obtained a score of 3.86 (very good

criteria). Student responses towards the gamification-based biology learning materials obtained an average score of 3.72 with very good criteria.

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