Development of Problem Based Learning E-module Based on Research Hormone Leptin Levels in Rats Hyperglycemic

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Abstract. One cause of low student understanding of the material is the hormone leptin, a less comprehensive learning resource. Problem Based Learning is one of the demands in education that must be taught to students, one of the ways to use the results of research on the levels of the hormone leptin in rats hyperglycemic as a learning resource. This study aims to develop a problem-based learning-based e-module based on research hormone leptin levels in rats hyperglycemic invalid and practical. The e-module is developed based on the stages of the ADDIE development model. The e-module has developed later through the validation stage of the material and media experts. The practicality test was carried out by educational practitioners and 15 students who had taken the Endocrinology course at the State University of Malang. The data analysis technique used quantitative data in the form of a validation scores of material experts, media experts, and practicality. The data collected in the form of qualitative data in the form of comments and suggestions validators. The results obtained from the results of the validation of material experts were 91.66%, teaching materials experts 92.11%, field trials expert practitioners 95.83%, and the average student response 86.54%. Based on these results, e-module can be very valid and practical for use in teaching and learning.
Keywords: Problem based learning, development, leptin hormone, research

Introduction

Education in college is carried out according to an educational curriculum reference called the Indonesian National Qualification Framework (KKNI) (Kemenristekdikti, 2015; Satriawati, 2016; Solikhah, 2015). The S1 level demands KKNI at level 6 (Kemenristekdikti, 2016). KKNI was developed for internal and external reasons, internal reasons in global challenges and competition, external reasons in quality gaps, various qualification rules, and various education (Direja, 2017; Mochtar, 2014). One of the universities implementing the KKNI is the State University of Malang, Department of Biology. Graduates of the undergraduate program must apply logical, critical, systematic, and innovative thinking or implement Science and Technology (IPTEK) (Kemenristekdikti, 2015). KKNI directs S1 graduates to have standard qualifications for attaining learning competencies in each field of expertise's affective, cognitive, and psychomotor aspects (Kemenristekdikti, 2015). This competency is applied to the Endocrinology subject, a

compulsory subject for the Department of Biology in health interest, State University of Malang.

In the observations found in the field, the Endocrinology course shows that there is a gap between learning outcomes and actual conditions, that the ability to analyze and solve student problems is still lacking. This is thought to be due to the use of unsupportive teaching materials. Teaching materials affect learning success, therefore the right teaching materials need, so the learning achievements can be done (Aqib, 2013; Asyhar, 2011). Based on interviews with a lecturer in the Endocrinology subject, it was explained that Endocrinology learning had used worksheets and videos were downloaded from the internet. This is also evidenced by the results of observations in Biology undergraduate students in semester 6 of the 2018/2019 academic year when answering questions, student answers are still in textbooks (according to what they read without self-analysis). Ways that can be done to improve the learning process, by design the learning, both from the teaching materials or the methods used (Ardiansyah et al., 2020; Rahmadani, 2019).

Problem Based Learning (PBL) is a learning model that is focused on problems (Aini et al., 2019; Aqib, 2013; Emiliasari et al., 2019; Widiawati et al., 2018; Yazar Soyadı, 2015) which is presented by educators where the learner is tasked with solving these problems with all knowledge and ability (Affriyenni et al., 2021; Dole et al., 2017; Sari et al., 2019; Yudawan et al., 2015). Therefore, learning with the PBL model needs to be developed in the 21st century (Mayasari et al., 2016).The problems presented in PBL are real or authentic problems that occur in real life (Gunantara et al., 2014; Pujianti and Rusyana, 2020). The application of PBL can increase learning activeness by motivating learners to actively provide responses, ideas, and arguments (Rusman, 2012; Setiawan, 2017).

The PBL model will be more effective if it is assisted by teaching materials as a learning resource to achieve learning objectives (Najahah, 2018; Prastowo, 2015; Sanjaya, 2008). The results of observations in the Endocrinology class in 2019 show that the teaching materials have not presented the material in the Endocrinology course in a constructivist and contextual manner. This causes students not to be able to link the concept of material with the problems of everyday life. Besides, students still have not studied independently based on the learning resources used. This shows that students still depend on the lecturers' explanation in understanding the material. The interview results with the lecturer who teaches the Endocrinology subject show that media is needed to present daily life problems because of the limited time for lecturers to develop media. Therefore, it is necessary to have teaching material innovation to support the learning process.

In accordance with the problems Biology students face at the State University of Malang to master the material independently, the appropriate teaching material to use is the e-module. The e-module is one of the interesting teaching materials and follows the development of science and technology (Chalkiadaki, 2018; Montagnes, 2000). The learning module is a systematic and interesting teaching material that includes content, methods and evaluation that can be used independently to achieve the expected competencies (Faot et al., 2016; Gujjar and Malik, 2007). The module being developed is an e-module. The advantages of e-module can make learning more interesting and interactive because it displays images and videos so that it makes it easier for students to understand the material described (Gujjar and Malik, 2007; hidayati et al., 2019; Krnel and Bajd, 2009; Satriawati, 2016), can integrate technology as a learning medium so that indirectly trains students to interact with technology (Seruni et al., 2020; Winarko et al.,

2013), does not require large space so that it reduces space usage, flexibility, functionality, lower prices than printed books, is easy to publish and is part of the conservation of paper raw materials (Laili et al., 2019; Sadiman et al., 2008).

Learning activities will be easier to implement if they are supported by contextual learning (Najahah, 2018; Rahmawati et al., 2021). Contextual learning can make the material easy to remember and understand (Johnson, 2002). One type of material that can be contextualized in Endocrinology learning is diabetes mellitus (DM) (Gofur et al., 2018). DM is a metabolic disease characterized by hyperglycemia because the body cannot produce enough insulin or use insulin effectively (Ayu Wulansari et al., 2018). Insulin functions to lower blood glucose levels (Johnson, 2002), therefore the pancreas produces more insulin (American Diabetes Association, 2014). Another hormone that plays a role in balancing glucose metabolism in DM is leptin. Leptin works as a counterweight to glucose and insulin production to keep it at normal levels by regulating food regulation and energy expenditure needed by cells (Nikmah and Dany, 2017; Sumadewi, 2017).

The purpose of this research is to produce a PBL-based e-module that is valid and suitable for students to use for endocrinology courses. The development of this e-module, students are expected to be able to independently study the material, evaluate achievements through practice and get direct feedback so that they can improve their understanding.

Methods

The research location for the development of learning tools was carried out at the Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang The research time for the development of this e-module was carried out in August 2019 – February 2020. The subjects in this study involved experts (lecturers) who would become validators regarding product content to be developed and 15 students in responding to the developed media.

This research is a type of research and development. The development carried out is developing the e-module. The e-module was adapted based on the ADDIE development stages by (Branch, 2009), but not all stages were carried out. Development measures undertaken, including (1) analyze, (2) design, (3) develop, and (4) Evaluate. The content design of the e-module was developed based on research on leptin hormone levels in hyperglycemic rats. The analysis stage serves to find out the problems and needs in the learning process. At this stage, learning observations were carried out, interviews with lecturers, and needs analysis questionnaires were provided to students. The design stage serves to design a guided module based on research results.

The development stage is carried out by developing the module design results made at the design stage (Branch, 2009). The development stage includes designing the content in the e-module, including research results, levels of the hormone leptin in hyperglycemic rats. At the development stage, a trial was conducted to determine the validity and practicality of the e-module being developed. Material expert validation is carried out by material experts who are lecturers who are experienced in biology, especially Endocrinology. Teaching materials experts are people who have experience in the development of teaching materials. Besides validation, field practice trials and preliminary tests were also conducted. Practitioner trials in the field were carried out to determine the suitability of the material presented in the e-module and to determine whether this material was suitable for use by students and in accordance with the learning outcomes to be achieved. Preliminary trials were carried out on students after the validation stage of each expert was carried out and had gone through the repair stage. The purpose of the

preliminary trial is to obtain data used in determining the practicality of teaching materials and to obtain a review of the e-module, which will be used as a consideration in improving the e-module. The preliminary trial was carried out on 15 students who had taken the Endocrinology course. Validation data for material experts, teaching materials, field practitioners, and student responses were obtained from a questionnaire containing questions about the material, teaching materials, and the suitability of the e-module with learning and e- module attractiveness. The data obtained are qualitative in suggestions and input, and quantitative data obtained from scoring. The scoring technique is carried out using a 1-4 Likert scale. The data analysis technique uses the calculation namely total of scores on the assessed aspect divided by total score multiplied by 100%.

The score obtained is then converted into certain criteria. Criteria used to determine the validity of teaching materials. Validation and practicality of the e-module is done with a rubric level of validity. Expert material validation must be 100%. Category of analysis of results of validity and practicality Table 1.

Tabel 1. Criteria for percentage of product

No	Practical criteria (%)	Level of validity
1.	81-100	Very valid; very practical; can be used with minor revisions
2.	61-80	Applicable; practical; can be used with minor revisions,
3.	41-60	Quite valid; practical; can be used but needs a small revision
4.	21-40	Less valid; needed is not used because it needs a lot of revision
5.	0-20	Not valid; not practical; can not be

(Akbar, 2013)

Results and Discussion

The product was developed in the form of teaching material, a PBL-based e-modules on the material of the endocrine system of the leptin hormone based on research results. E-module can be used for independent learning by students (Asyhar, 2011; Sudjana, 2017). The use of e-modules can improve and train students' technological literacy habits (Silalahi, 2020)(Silalahi, 2020). Where it is important to have students as a young generation in the current era of industrial revolution (Pramana et al., 2020).

The e-module consists of several parts, namely introduction, content, and closing (Paulina and Purwanto, 2001). The introduction consists of a cover, table of contents, e- module profile , instructions for using e- module , competencies. The content is the most important component in the e- module : LKM, material, questions, and answer keys (Mulyasa, 2008). The closing section consists of a bibliography, glossary (Anwar, 2010; Daryanto, 2013).

The needs analysis results showed that students were unable to think at a higher level and were less able to connect the media used, the media used by the LKM, and videos downloaded from the internet. Students are still unable to learn independently based on the learning resources used. It can be seen that students still depend on the lecturer's explanation in understanding the material. lecturers need media that present daily life problems because of the limited time in developing media. therefore, the research objective is a PBL e-module product based on research results for endocrinology courses tested for validity and practicality. Based on previous research that e-modules based on PBL can

increase critical thinking ability (Aini et al., 2019; Loyens et al., 2015; Sari et al., 2019; Seruni et al., 2020) and students' cognitive learning outcomes (Rahmawati et al., 2021; Silalahi, 2020).

The design stage is done by planning all the components that will be included in the e-module (Branch, 2009). Once the design is complete, the e-module is developed. At the design stage, the PBL-based module design prototype includes arranging objects in the e-module. The e-module developed is expected to be an alternative learning resource that helps students understand the hormone leptin (Sari et al., 2019). The core part of the e-module contains learning activities. The PBL-based e-module based on research results consists of three learning activities: the mechanism of action of the hormone leptin, the hormone leptin, and DM, and the hormone leptin and the hormone ghrelin.

Each learning activity is equipped with the PBL model syntax, namely 1) connecting with the problem, 2) setting up the structure, 3) visiting the problem & revisiting the problem, 4) producing a product performance, 5) evaluating performance and the problem (Delisle, 1997). The connecting with the problem stage presents a phenomenon. The phenomenon that is published is the result of research that has been done. The results of this study can provide authentic learning experiences for students (Peniati and Parmin, 2012; Watini, 2019), increase student understanding (Oktaviana et al., 2015). Provide information related to developments and findings related to the material discussed (Widayati et al., 2010), practical use in learning (Amin, 2010; Faot et al., 2016), improves the quality of learning (Yahya, 2010), and can have the adaptability to science and technology (Mahfudhillah et al., 2017).

The PBL syntax is designed in student worksheets located at the beginning of each learning activity (Daryanto, 2013). The phenomenon contained in each learning activity is the result of research conducted. Research results can provide authentic learning experiences for students (Peniati & Parmin, 2012; Tasir & Pin, 2012), increase student understanding, and provide information about developments and discoveries in the content discussed. In addition, the research results are practices to be used in learning (Faot et al., 2016), improve the quality of learning, and have the ability to adapt to science and technology (Mahfudhillah et al., 2017; Poedjiadi, 2010). The study results were published in the leptin hormone level module based on studies in hyperglycemic rats. This is in accordance with previous research that has been carried out, that contextual learning can improve student learning outcomes (Aqib, 2013; Setiawan & Sudana, 2019).

Each learning activity ends with a formative test. Formative tests are equipped with critical answers so that students can measure their understanding independently according to the characteristics of the e-module (Ali et al., 2010; Septora, 2017). The formative test is in the form of essay questions. Essay questions are used because they have a better information function value (Susongko, 2010). Students are given the freedom to express their understanding. This is useful for measuring the level of achievement of cognitive learning outcomes. The final part of the e-module consists of a summative test and critical answers, a glossary, and references. The summative test is used to measure students' overall understanding of all the contents of the e-module (Hidayah and Suparman, 2019; Sudjana, 2017). The glossary helps students learn the definitions of terms in the modules and understand the studied concepts (Faot et al., 2016; Post et al., 2019; Ucar & Trundle, 2011; Elfeky et al., 2020).

The PBL e-module based on the research results has developed and validated by material experts, instructional media experts, and field practitioners. Validation aims to find out the weaknesses that exist in modules and is used as materials for making improvements (Belawati, 2003; Mahirah, 2017) and produce modules according to student needs (Asyhar, 2011). The material expert validation gives value category is very valid for all aspects of validation. Aspects of material expert validation include titles, examples or illustrations, images/photos/videos, language, activities 1, 2, and 3 in the aspects of

depth/breadth of material, the correctness of material concepts, updating of material, contextuality of material (Depdiknas, 2014). The material contained in the e-module must be correct, precise, and accurate (Prawoto, 1989). The suitability of material content is very important in preparing e-modules as teaching materials because e- modules apply constructive learning (Bada & Olusegun, 2015; Fernando & Marikar, 2017), help students build their understanding (Oktaviana et al., 2015). The validity criteria of material experts indicate the correctness of the material substance in the e-module.

The development phase includes content design, supporting media development, user manuals for students and lecturers, formative revisions, and preliminary trials. (Branch, 2009). At the development stage, module validation is carried out. Validation was carried out by material experts, learning experts, and field practitioners to validate the modules developed based on the research results (Daryanto, 2013). Validation is intended to find out the weaknesses of the e-module and be used as material for improvement and produce modules that are in accordance with the needs of students.

Material expert validator who assesses the feasibility of the material and the suitability of the module content with the Endocrinology lecture material. The results of material expert validation for the PBL-based leptin endocrine system e-module percentage of 98.95% with a very valid category can be used for the implementation of the effectiveness test (Akbar, 2013). The advice given by the validator is that the description of the image is written in Indonesian, improving the explanation about the relationship between the hormone leptin and ghrelin, the hormone leptin, and obesity. The summary of the results of material expert validation can be seen in Table 2.

Table 2. Results of PBL-based e- module validation by material experts

No.	Rated aspect	Number of Aspects	Maximum Score	Earnings Score	Results of validation (%)	Category
1.	Title	3	12	12	100	Very Valid
2.	Example or Illustration	3	12	12	100	Very Valid
3.	Image / Photo / Video	3	12	11	91.66	Very Valid
4.	Language	3	12	11	91.66	Very Valid
5.	Depth / Extent of Material	3	12	12	100	Very Valid
6.	The Truth of the Concept of Matter	3	12	12	100	Very Valid
7.	Material up-to-date	3	12	12	100	Very Valid
8.	Contextual Material	3	12	12	100	Very Valid
9.	Depth / Extent of Material	3	12	12	100	Very Valid
10.	The Truth of the Concept of Matter	3	12	12	100	Very Valid
11.	Material up-to-date	3	12	12	100	Very Valid
12.	Contextuality of the Material	3	12	12	100	Very Valid

13.	Depth / Extent of Material	3	12	12	100	Very Valid
14.	The Truth of the Concept of Matter	3	12	12	100	Very Valid
15.	Material up-to-date	3	12	12	100	Very Valid
16.	Contextuality of the Material	3	12	12	100	Very Valid
	Earnings score	12	192	190	98.95	Very Valid

A decent product must be valid from the aspect of the title, example or illustration, picture/photo/video, language, activities 1, 2, and 3 on the aspect of depth/breadth of the material, the truth of the concept of the material, the up-to-date of the material, the contextuality of each material. The conclusion from the material expert is that the e-module can be used in learning with a minor revision. Media expert validators assess the feasibility of media development. Based on the media validity assessment results on the PBL-based e-module, it was found that 92.11% was very valid. PBL-based e-module can be used in the learning process if it has a validity value of more than 85.01% (Akbar, 2013). PBL-based e-module material must be revised according to the suggestions and comments of the validator before implementation in the field. Suggestions given by the consistency validator in the use of fonts. The summary of the results of media expert validation can be seen in Table 3.

Table 3. Results of PBL-based e- module validation by media experts

No.	Rated aspect	Number of Aspects	Maximum Score	Earnings Score	Results of validation (%)	Category
1.	Self Instruction	6	24	23	95.83	Very Valid
2.	Stand Alone	2	8	7	87.5	Very Valid
3.	Adaptive	3	12	11	91.66	Very Valid
4.	User friendly	3	12	11	91.66	Very Valid
5.	Layout	5	20	18	90.00	Very Valid
	Earnings score	19	76	70	92.11	Very Valid

The results of the validation of learning experts are very valid for all aspects of validation. Expert learning validation includes self-instruction, stand-alone, adaptive, user-friendly layout (Ministry of National Education, 2014). The linguistic aspect must use language that is easy to understand and uses proper spelling (Akbar, 2013). The media expert concludes that the e-module can be used in learning with minor revision. Field practitioners assess the feasibility of the media in use in learning. Based on the results of the validity assessment by field practitioners on the PBL-based e-module, 95.83% was found to be very valid. PBL-based e-modules can be used in the learning process if they have a validity value of more than 85.01% (Akbar, 2013). This category shows that overall

PBL-based e-modules that have been developed can be implemented in learning. However, it needs to be revised according to the validator's suggestions and comments before implementation in the field. The advice given by the validator is to improve grammar at the connecting with the problem stage, the obesity material on manifestation needs to be added. The summary of the expert validation results of field practitioners can be seen in Table 4.

Table 4. Results of PBL-based e- module validation by field practitioners

No.	Rated aspect	Number of Aspects	Maximum Score	Earnings Score	Results of validation (%)	Category
1.	Completeness of Components	3	12	12	100	Very Valid
2.	Characteristics	3	12	11	91.66	Very Valid
3.	Presentation	3	12	12	100	Very Valid
4.	Language	3	12	11	91.66	Very Valid
5.	Problem Based Learning	3	12	12	100	Very Valid
6.	Critical Thinking Ability	3	12	11	91.66	Very Valid
7.	Cognitive Learning Outcomes	3	12	12	100	Very Valid
8.	Theory	3	12	12	100	Very Valid
9.	Access and Use	3	12	11	91.66	Very Valid
10.	Learning Tools	3	12	11	91.66	Very Valid
	Earnings score	30	120	115	95.83	Very Valid

Based on the PBL-based e- module validation results by field practitioners, 95.83% is very valid. This category shows that the overall PBL-based e-module that has been developed can be implemented in learning. The results of expert validation of field practitioners very practice for all aspects of validation. Aspects of field practitioner expert validation include the completeness of components, characteristics, presentation, language, problem-based learning, critical thinking skills, cognitive learning outcomes, materials, access and use, and learning tools. The conclusion from the expert field practitioners is that the e-module can be used in learning with minor revision. The response of 15 students to the PBL-based e-module in the pre-test was 86.54%, with a very valid category. This shows that PBL-based e-modules are feasible but need a minor revision before field trials. A summary of the results of the validation of student response analysis can be seen in Table 5.

Table 5. Results of Student Response Analysis

No.	College student	Mean Value (%)	Category
1.	1st	84.61	Very Practical
2.	2nd	100	Very Practical
3.	3rd	78.84	Practical
4.	4th	92.30	Very Practical
5.	5th	84.62	Very Practical
6.	6th	90.38	Very Practical
7.	7th	88.46	Very Practical
8.	8th	84.61	Very Practical
9.	9th	94.23	Very Practical
10.	10th	86.54	Very Practical
11.	11th	82.69	Very Practical
12.	12th	80,80	Very Practical
13.	13th	82.69	Very Practical
14.	14th	82.69	Very Practical
15.	15th	84.62	Very Practical
Earnings score		1208.08	
Validity Value		86.54	Very Practical

The next e-module is revised based on suggestions from validators and practitioners. Valid and practical modules will be used in the learning process. The results of valid and practical e-modules can be seen in Figure 1 and Figure 2.
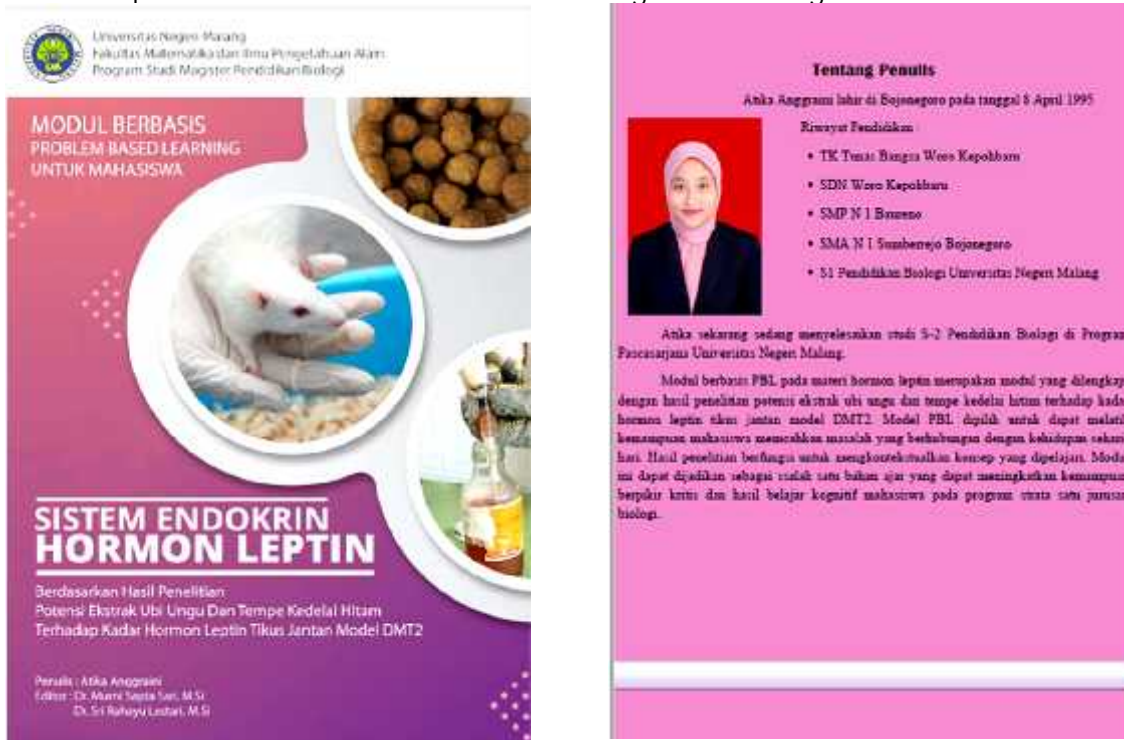

Figure 1 front and back cover of the e-module

Figure 2 Syntax of integrated PBL learning in the module

The advantages of PBL-based e- modules include (1) the material on the PBL-based e-module which was developed based on the results of research on the potential of purple sweet potato in rats hyperglycemic on hormone leptin levels in rats, (2) PBL-based e- module material besides being based on The results of the research are taken from various references to the endocrine system of the leptin hormone, (3) the content of the e- module material refers to subject learning outcomes (CPMK), (4) the e-module contains PBL syntax in LKM, so that students are trained to solve problems using e-PBL based e-module (Rahmatika et al., 2020), (5) PBL based e-module equipped with answer keys, scores and descriptors, and self-assessments (Warsono & Hariyanto, 2013), (6) The resulting e-module is valid and practical (Fonda & Sumargiyani, 2018; Imansari & Suryanngsih, 2017; Irwansyah et al., 2017). The shortcomings of the PBL based e-module include,1) the PBL based e-module only discusses the material of the leptin hormone, not yet accommodating the whole endocrinology material, 2) Various pictures displayed in the e-module are still sourced from other sources (Morrison & Ross, 2004).

Conclusion

Products in the form of PBL-based e-modules have a been successfully developwd with a percentage of eligibility from materials experts, teaching materialsexperts and field practitioner expert trials of 98.95, 92.11, and 95.83%. In terms of student responses, the percentage is 86.54%. It can be concluded that the PBL-based e-module on leptin hormone material is considered very feasible and very good to be used as teaching material in endocrinology learning.

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