Development of PjBL-Based Electronic Module on Reaction Rate Material for Class XI MIPA Senior High School

Haryanto(✉), M. Dwi Wiwik Ernawati, Sudarmin, Aulia Sanova, Dea Ristria Ariani, and Adriyan Ardi Rahman

Faculty of Teaching and Education, Universitas Jambi, Jambi, Indonesia
haryanto.fkip@unja.ac.id

Abstract. Chemistry subjects are subjects that focus on how students understand related to the composition, structure, properties, changes, and energy that accompanies it and can be utilized by humans for the speed of life. One of the learning models that can be applied to chemistry learning is PjBL. Project Based Learning (PjBL) is a learning model that uses problems as an initial stage in collecting and integrating new knowledge gained from real activity experience. This study aims to determine whether the PjBL-based e-Module on the reaction rate material for class XI MIPA SMA in the form of an android application developed is feasible theoretically and practically. This research is a development research using the Lee & Owens development model. The research instruments used were interview guide sheets and questionnaires. The product resulting from the development was validated by material experts and media experts and assessed by the teacher which was then tested one by one and tested in small groups. The data analysis techniques used are qualitative data analysis (comments and suggestions) and quantitative data analysis (answer scores and percentages). The results of this study obtained the average score of material experts and media experts from each validation of 3.643 (very feasible with revision) percentage 91.08%; 3.857 (very feasible without revision) with 96.43% for material and 3.857 for media (very feasible with revision) with 96.43%; 4.00 (very feasible without revision) with 100% and declared feasible to be tested. Furthermore, based on the teacher's responses and assessments which contained that the e-Module developed was appropriate and feasible to be tested on students, with an average score of 3,824 (very feasible). And getting a very good response from students with the percentage of student responses in the one-on-one test of 85% and small group trials of 94%. Based on the development process and research results, it is concluded that this e-Module is feasible to use theoretically and practically as one of the learning media on reaction rate material and has the potential to improve critical thinking skills based on expert opinions and teacher assessments.

Keywords: E-Modul · Laju Reaksi · PjBL

D. A. Kurniawan (Ed.): GDIC 2022, ASSEHR 772, pp. 1153–1162, 2023.
https://doi.org/10.2991/978-2-38476-110-4_115

1 Introduction

Education is a human empowerment effort that can be done by developing self-potential, personality, skills, intelligence and noble character [1–3]. With education that is structured based on the provisions of appropriate basic values, it will produce quality educational outputs in accordance with the goals of education in Indonesia.

To achieve the goals of education in Indonesia, there are several things that must be considered including components in learning such as models, methods, objectives and media [4–6]. Paying attention to this will make learning activities fun and motivate students to play an active role in the space and opportunities that have been given. Without a clear model selection and use of media, the learning process will be less interesting and the results obtained are not optimal as expected [7–9]. The choice of learning model will be very influential in the activeness of students in the classroom.

One of the learning models that involve student activity and develop students' thinking skills in the learning process is PjBL. The Project Based Learning (PjBL) learning model provides opportunities for students to be active in the learning process by producing a product based on a problem from the surrounding environment so as to make learning more meaningful [10–12]. The integration of the PjBL model can be done through teaching materials, one of which is in the form of e-Modules.

E-Modules are developed from modules using electronic technology consisting of text, images, graphics, animations that are suitable for use in learning with easy-to-understand language, in hopes of making it easier for students to achieve learning goals [13–15]. The existence of various interesting features makes this e-Module more attractive to students so that students' abilities can increase.

This research is in line with previous research conducted by [16, 17] but there is a difference between the researcher and previous research, namely in this development research the researcher used the Lee & Owens development model. The urgency of this research is that the existence of PjBL-based e-modules can improve student learning outcomes and their abilities. Therefore, the purpose of this research is to produce an e-module product based on PjBL material for reaction rate class XI MIPA SMA, to determine the feasibility and assessment of an e-module product based on PjBL material for class XI MIPA SMA class XI.

2 Research Methods

This study uses a quantitative approach with the type of Research and Development (R&D) development research which refers to the Lee & Owens development model consisting of the Analysis, Design, Development, Implement, and Evaluate stages (Kurni, Marzal, & Zurweni, 2022; Purwanto, Fatirul, & Walujo, 2022; Wahyuningtyas, Anggraini, Andini, Rosita, & Sari, 2022).

This research was conducted during November 2021 to March 2022. The research location in this study was SMA N 10 Jambi City. The test subjects in this study were students of class XI MIPA SMA N 10 Jambi City. The division is a small group trial of 12 students The e-module development procedure can be described in Fig. 1.

The stages of the development of the E-module are as follows:

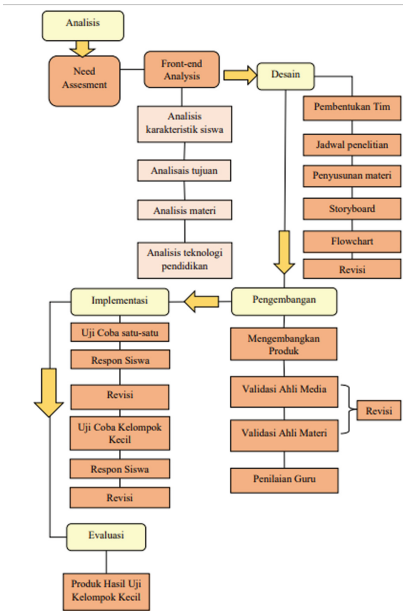


Fig. 1. Lee & Owens. Model Development Procedure

The first stage is analysis (Analysis). At this stage of analysis, it aims to find out and determine the conditions or circumstances that actually occur in the field. At this stage, several stages are carried out, namely needs analysis, student characteristics analysis, objective analysis, material analysis, and educational technology analysis.

The second stage is Design. This design stage is the planning stage of your multimedia project. Planning is probably the most important factor in the success of your project. Projects often fail due to failure in planning.

The third stage is Development (Development). Development is the process of making the design or design a reality. Which means, if a particular software or application is needed in the design to support the developed learning media, then all the components that have been designed are developed through improvements so that they are ready to be uploaded into the application. Likewise, the learning environment that will support the learning process must all be prepared at this stage. The development process is basically the same, firstly creating a framework, then developing appropriate media elements, then reviewing and revising the product, and finally implementing the finished product. Multimedia development is most successful if design-time prototypes, evolutionary developments, and templates are used.

The fourth stage is implementation (implementation). Implementation is a real step to implement the learning system that we are making. That is, at this stage everything that has been developed will be tested or set in such a way according to its role or function so that it can be implemented. For example, if you need a certain application or software, then the application or software must be installed. If the arrangement of the environment

must be certain, then the environment or certain settings must also be arranged. Then it is implemented according to the initial scenario or design.

The fifth stage is evaluation (evaluation). The last stage is Evaluation, the developer evaluates the product that has been made. The evaluation carried out in this development research is an evaluation that is oriented towards the validity of the multimedia developed through the validation of media experts, material experts and the results of product trials. This evaluation stage is related to the previous stage, namely the fourth stage. The evaluation stage is carried out after each series of activities in the fourth stage (expert validation and product testing) is carried out.

The data used in this development research are quantitative and qualitative data which are then analyzed descriptively statistically and concluded as input to improve or revise the product that has been developed. Quantitative data obtained from the validation results in the form of assessment scores from material experts, media experts, teachers, and students using a scale of four with a range of values: 4 for the very decent category, 3 for the decent category, 2 for the fairly decent category, and 1 for the decent category. Less worthy. Quantitative data were also obtained from the questionnaire scores. Meanwhile, qualitative data were obtained through interviews.

Data collection techniques used in this study include: interviews, questionnaires, observation. Interviews were conducted by interviewing teachers about the Chemistry learning process with the theme Rate of Reaction at school. The technique of collecting data through questionnaires was carried out during the validation of media and material experts, as well as in the field trials the questionnaires were filled out by students. Observation is used to describe the description of Chemistry learning activities using e-modules.

The instruments used as data collection are module validation sheets for media and material experts, teacher and student response questionnaires. This instrument must be validated by an expert.

E-module feasibility data analysis technique uses a Likert scale. The score obtained is then converted into a value with a scale of four. The feasibility of the results of the development of e-modules both from the material and media aspects, from the data in the form of scores converted into qualitative data with a scale of four. The reference for changing the score to a scale of four is as follows in Table 1.

Table 1. Score Conversion on a 4. Scale

Score	Interval	Information
4	>3,25 – 4,00	Very good
3	>2,50 – 3,25	Well
2	>1,75 – 2,50	Not good
1	1,00 – 1,75	Very Not Good

3 Results and Discussion

The analysis phase aims to analyze and determine the learning conditions. This analysis phase consists of five main steps, namely needs analysis, analysis of student characteristics, analysis of objectives, analysis of materials, and analysis of educational technology.

The analysis of the problem was carried out by SMA N 10 Jambi City. The purpose of this analysis is to raise and define the basic problems faced in learning chemistry with reaction rates at SMA N 10 Jambi City, so that the development of PjBL-based e-modules is needed. The results of interviews with the teaching team (teachers) stated that SMA N 10 Jambi City used the 2013 Curriculum, and the teaching materials used in class were worksheets and chemistry textbooks purchased by each student. The learning method applied is the lecture, discussion, and demonstration (paracticum) method. Observations showed that in the learning process students were less actively involved.

Furthermore, student analysis was carried out. Based on the results of interviews and observations, it can be concluded that the ability of students to receive and respond to subject matter is different, thus affecting the interest, interest and enthusiasm of students when the learning process takes place. So that when the teaching and learning process takes place, it is not uncommon for students to pay less attention and be busy with other activities.

The design or design stage consists of the preparation of tests, selection of media that is suitable for the purpose, selection of formats, and initial design. The preparation of the test was carried out to determine how the assessment of students' conceptual understanding of learning. Assessment of students' conceptual understanding of learning is carried out in several stages, namely the initial stage in the form of a student response questionnaire to learning Chemistry.

The media used to deliver the subject matter are e-modules and printed textbooks. In learning, student worksheets (LKS) are also used as supporting media, especially supporters in the practicum process.

The format of the electronic module (e-module) was developed in accordance with the existing needs at the planning stage. Electronic module design (e-module) uses the format proposed by Prastowo (2011). The following format for the electronic module (e-module) was developed (Table 2).

The e-module design was produced by researchers as the initial product of the development of an interactive electronic module (e-module). The e-module cover design can be seen in Fig. 2.

The contents of the e-module consist of material descriptions, practicum worksheets, practice questions and summaries, packaged in such a way that students can be more active in the learning process (Fig. 3).

The final part of the e-module consists of an evaluation and a bibliography. The development phase consists of expert validation and e-module testing. Instrument validation was carried out with the aim of obtaining valid and appropriate instruments to be used in assessing e-module products. The components assessed in the research instrument include the components assessed in the research instrument including aspects of statements in accordance with the instrument grid, aspects of conformity of content/material,

Table 2. Outline of PjBL-Based Electronic Module

No	Beginnings	Contents Section	Part End
1	Cover	Material Title	Bibliography Evaluation
2	Foreword	Material Description	
3	List of contents	Exercises	
4	Competency standards	LKS	
5	Basic competencies	Summary	
6	Learning objectives		
7	Scope		
8	Introductory Material		

Fig. 2. Design of the e-module cover

and aspects of conformity with learning. Data on the results of the assessment of research instruments are presented in Table 3.

3 Suitability for Learning 4.00 Of all the aspects assessed by the validator, this research instrument is said to be suitable for use with revisions because all aspects in the instrument are in the category suitable for use with revisions. However, the parts that need to be repaired must be revised before being used. Media validation is carried out to measure the feasibility of the e-module from the media aspect. The two media experts filled out an instrument sheet to assess the overall quality of the media. Media validation consists of four aspects that are evaluated, namely the design aspect, the second display aspect, the third programming aspect, and the fourth utilization aspect.

Material expert validation is carried out to measure and assess the degree of validity of the material and content of the developed e-module. The material assessment consists of four aspects of introduction, content, summary, and aspects of training/evaluation.

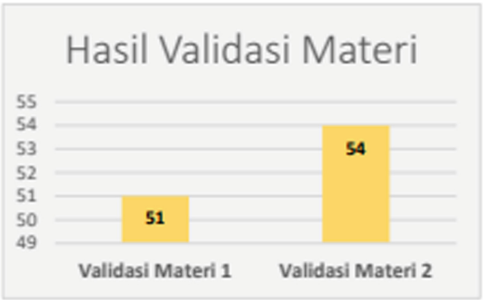
Fig. 3. Design of the e-module Contents

Table 3. Results of Data Analysis Validation of Research Instruments

No	Assessment Aspect	Average Score	Criteria
1	Statements according to the instrument grid	3,00	Worth using with revision
2	Conformity of Content/Material	4,00	

Simulation of the use of e-modules is carried out by the teacher with the aim of giving an idea to students about the use of electronic modules (e-modules). The simulation results show that the electronic module (e-module) can be used as a source of student learning and teaching materials for teachers both in the classroom and outside the classroom.

The results of material validation from two material experts can be seen in Figure 6.



Based on the data from the assessment results of two material experts on all aspects, an average of 3.3 was obtained with a very decent category. The average score is described in the achievement of the average score of each aspect, including the preliminary aspect

Table 4. Results of Student Response Scores in Small Group Trials

No	Assessment Aspect	Average Score	Criteria
1	Learning materials	3,36	Very Worthy
2	Appearance	3,37	Very Worthy
3	Programming	3,4	Very Worthy
	Total Score	3,37	Very Worthy

consisting of 5 indicators reaching an average score of 3.2 which is in the proper category. The content aspect with 14 indicators got a score of 3.1 is in the decent category. Furthermore, the summary aspect which consists of 3 indicators achieves an average score of 3.8 in the appropriate category and the last is the exercise/evaluation aspect with 5 indicators, an average score of 3.0 is obtained in the appropriate category.

After being declared feasible by media and material experts, it was continued with small group trials. The results of small group trials are used as input to researchers about the products developed before being tested in the field. Data on student responses to small group trials are presented in Table 4.

Based on the results of the small group test assessment, an average of 3.37 was obtained with very feasible criteria. This shows that the developed e-module can be tested in the field in large groups. The results of the large group trial were used to assess and see the effectiveness of the developed e-module (Table 4).

This research is in line with previous research conducted by (Herawati & Muhtadi, 2018; Siregar & Harahap, 2020) but there is a difference between the researchers conducted with previous research, namely in this development research the researcher used the Lee & Owens development model. The urgency of this research is that the existence of PjBL-based e-modules can improve student learning outcomes and their abilities. Thus, the novelty of this research is the development of e-modules using the R&D development method with the Lee and Owens development model. The Lee and Owens model consists of 5 stages, namely Analysis, Design, Development, Implement, and Evaluate.

4 Conclusion

Based on the research conducted by the researchers, it can be concluded that the PjBL-based e-module on the reaction rate material using the Lee and Owens development model R&D development method obtained results conceptually “very good” based on the assessment of material and media expert validators. So it can be stated that this e-module is suitable for use in the chemistry learning process.

References

1. N. Sugrah, S. H. Nur Abu, N. A. Rahman, K. A. Rakhman, M. Danial, and M. Anwar, “Assessment of Processes and Resources for Knowledge of Skills of a Chemistry Laboratory

at the Senior High School of Ternate Island," *J. Curric. Teach.*, vol. 8, no. 1, p. 11, 2019, https://doi.org/10.5430/jct.v8n1p11.
2. C. C. Giac and P. N. Tuan, "The actual situation of practising reading skills in teaching chemistry in english at Vietnamese high school," *Humanit. Soc. Sci. Lett.*, vol. 9, no. 3, pp. 468–486, 2021, https://doi.org/10.18488/journal.61.2021.93.468.486.
3. A. Erdem, "A Study on Teachers' Views on the Use of Technology to Improve Physics Education in High Schools," *J. Educ. Train. Stud.*, vol. 7, no. 4, p. 142, 2019, https://doi.org/10.11114/jets.v7i4.4019.
4. A. Asmuni, "A Critical Study of Al-Farabi Philosophy Implementation at Education non Islamic Higher Education in Indonesia," *Din. Ilmu*, vol. 21, no. 2, pp. 491–500, 2021, https://doi.org/10.21093/di.v21i2.3913.
5. S. Gunara and T. S. Sutanto, "Enhancing the Intercultural Competence Development of Prospective Music Teacher Education: A Case Study in Indonesia," *Int. J. High. Educ.*, vol. 10, no. 3, p. 150, 2021, https://doi.org/10.5430/ijhe.v10n3p150.
6. S. Wahjusaputri and B. Bunyamin, "Development of teaching factory competency-based for vocational secondary education in Central Java, Indonesia," *Int. J. Eval. Res. Educ.*, vol. 11, no. 1, pp. 353–360, 2022, https://doi.org/10.11591/ijere.v11i1.21709.
7. D. B. Sanjaya, I. K. Suartama, I. N. Suastika, and Sukadi, "The effect of the conflict resolution learning model and portfolio assessment on the students learning outcomes of civic education," *Int. J. Instr.*, vol. 15, no. 1, pp. 473–488, 2022, https://doi.org/10.29333/iji.2022.15127a.
8. I. N. Suastika, I. K. Suartama, D. B. Sanjaya, and K. S. Arta, "Application of multicultural-based learning model syntax of social studies learning," *Cypriot J. Educ. Sci.*, vol. 16, no. 4, pp. 1660–1679, 2021, https://doi.org/10.18844/cjes.v16i4.6030.
9. M. M. Chusni, S. Saputro, S. Surant, and S. B. Rahardjo, "Enhancing Critical Thinking Skills of Junior High School Students through Discovery-Based Multiple Representations Learning Model," *Int. J. Instr.*, vol. 15, no. 1, pp. 927–945, 2022, https://doi.org/10.29333/iji.2022.15153a.
10. N. Jalinus, Syahril, and R. A. Nabawi, "A comparison of the problem-solving skills of students in pjBL versus CPjBL model: An experimental study," *J. Tech. Educ. Train.*, vol. 11, no. 1, pp. 36–43, 2019, https://doi.org/10.30880/jtet.2019.11.01.005.
11. S. Suwarno, W. Wahidin, and S. H. Nur, "Project-based learning model assisted by worksheet: It's effect on students' creativity and learning outcomes," *JPBI (Jurnal Pendidik. Biol. Indones.*, vol. 6, no. 1, pp. 113–122, 2020, https://doi.org/10.22219/jpbi.v6i1.10619.
12. R. Mursid, A. H. Saragih, and R. Hartono, "The Effect of the Blended Project-based Learning Model and Creative Thinking Ability on Engineering Students' Learning Outcomes," *Int. J. Educ. Math. Sci. Technol.*, vol. 10, no. 1, pp. 218–235, 2022, https://doi.org/10.46328/ijemst.2244.
13. R. C. Johan, G. Rullyana, and A. Ardiansah, "Hyper content e-module in information behavior course with the assistant of screencast," *J. Educ. Learn.*, vol. 16, no. 2, pp. 210–218, 2022, https://doi.org/10.11591/edulearn.v16i2.20339.
14. A. Rahman, B. Wibawa, and S. Sumantri, "Develop English Electronic Module for Tourism Through Analysis of Learner's and Context," *Educ. Q. Rev.*, vol. 5, no. 1, 2022, https://doi.org/10.31014/aior.1993.05.01.417.
15. C. Charlina, E. Septyanti, T. P. Mustika, and A. Rahmi, "Electronic module as learning needs to write exposition texts for junior high school students," *J. Educ. Learn.*, vol. 16, no. 2, pp. 219–225, 2022, https://doi.org/10.11591/edulearn.v16i2.20402.
16. A. D. Siregar and L. K. Harahap, "Pengembangan E-Modul Berbasis Project Based Learning Terintegrasi Media Komputasi Hyperchem Pada Materi Bentuk Molekul," *JPPS (Jurnal Penelit. Pendidik. Sains)*, vol. 10, no. 1, p. 1925, 2020, https://doi.org/10.26740/jpps.v10n1.p1925-1931.

17. N. S. Herawati and A. Muhtadi, "Pengembangan modul elektronik (e-modul) interaktif pada mata pelajaran Kimia kelas XI SMA," *J. Inov. Teknol. Pendidik.*, vol. 5, no. 2, pp. 180–191, 2018, https://doi.org/10.21831/jitp.v5i2.15424.