JURNAL PENDIDIKAN KIMIA (JPKIM)
ISSN: 2085-3653| e-ISSN: 2549-3116

J. Pendidik. Kim 2023, 15(3), 281 – 291
DOI 10.24114/jpkim.v15i3.47366

Research Article

Development of project-based interactive e-modules in accordance with the IQF integrated curriculum concept in learning organic chemical reactions to improve student chemistry learning outcomes

Bajoka Nainggolan, Anna Juniar, and Ramlan Silaban

Department of Chemistry, Universitas Negeri Medan, Medan-20221, Indonesia

Received 15 June 2023 ♦ **Revised** 26 October 2023 ♦ **Accepted** 07 November 2023

Citation: Nainggolan, B., Juniar, A., & Silaban, R. (2023). Development of project-based interactive e-modules in accordance with the IQF integrated curriculum concept in learning organic chemical reactions to improve student chemistry learning outcomes. Jurnal Pendidikan Kimia (JPKIM), 15(3), 281–291. https://doi.org/10.24114/jpkim.v15i3.47366

Keywords

Development of interactive
IQF-based curriculum
Project-based
Valid and effective e-modules

Corresponding author:
E-mail: b.nainggolan@unimed.ac.id
(Bajoka Nainggolan)

Abstract

Project-based interactive learning is the right choice to encourage students to learn actively and effectively to improve their learning outcomes. The aim of the research is to find project-based interactive e-Module teaching materials that are valid, effective, standard, suitable for use. Research stages: Needs analysis; e-Module development; standardization validation; individual, small and large group trials; effectiveness test, and test students' perception of satisfaction. The research uses the ADDIE method. Sample: Curriculum, teaching materials from publishers A and B, expert validators and 45 students. Test the feasibility and effectiveness of the e-Module, measuring the increase in learning outcomes and student satisfaction using test instruments. Data were processed and analyzed descriptively using SPSS. Research findings: the interactive e-Module teaching materials developed are valid, effective and standard, suitable for use. The product was effective in small group trials with student learning outcomes of (M 79.35%), large group (M= 79.85%), high and effective category. Respondents' assessment of the product was very valid, suitable for use (M = 3.81). The student satisfaction index is very satisfied (M = 88.80%). Hypothesis testing with paired ttest obtained sig. 0.011. Because sig < α (0.011 < 0.05), there are differences in post-test and pre-test learning outcomes. In conclusion, the project-based interactive e-Module teaching materials developed are valid, effective, standard, and suitable for use to improve student chemistry learning outcomes.

Introduction

The application of a curriculum based on the Indonesian National Qualifications Framework (IQF) at LPTK aims to increase the resources for prospective teacher graduates who are superior, qualified, productive, capable and skilled at managing learning with full responsibility as a professional teacher. This is in line with the statement (Khoirina et al., 2022; Santoso et al., 2023) that university graduates in Indonesia are expected to have lives that are able to compete globally as human beings who are superior, qualified, productive, and contribute to the life of society, nation and state.

One of the teaching methods that are in accordance with industry 4.0 is the project-based learning method, in which students work independently or collaboratively to solve problems given by lecturers. Chemistry learning is considered as part of basic science, a key to intellectual life and technological developments in science. Classical barriers between chemistry and basic science cannot be distinguished and gradually overlap with other sciences (ACS, 2015) The actual development of project-based interactive e-Module teaching materials in the Chemistry Education Study Program has not been carried out properly in the application of the integrated curriculum concept of the IQF since 2016 until now. Based on this, the development of interactive teaching materials needs to be carried out on the basis of the IQF integrated curriculum concept to achieve superior and competitive education. The competence to be achieved is to improve the quality of graduates who are qualified and competitive in learning. Quality competence and competitiveness have an impact on the

quality of graduates to be accepted in the world of work and able to play a role in the development of competitive globalization.

Based on data from the program for international student assessment (PISA) study, the achievements of students in Indonesia in the field of science in 2012 ranked 64th out of 65 countries (OECD, 2014). In 2015, it ranked 62nd out of 70 countries (OECD, 2016) and in 2018 ranked 70th out of 78 countries (OECD, 2019). The low ranking can be seen from the chemistry UN score as part of science, nationally the average national chemistry UN score in 2016 was 55.45 (Puspendik, 2016), in 2017 it was 57.80 (Puspendik, 2017), in 2018 it was 50.91 (Puspendik, 2018), and in 2019 it was 50.99 (Puspendik, 2019). The acquisition of chemistry scores is relatively low and becomes a challenge for teachers to increase UN scores to reach the specified KKM 7.0. Based on this, it is necessary to increase the chemistry competence of prospective teacher students to produce superior, tough and professional teachers. One of the strategies that can be implemented is through updating learning scenarios that are interactive, practical and effective.

Based on a case study survey of a number of chemistry teachers, they argued that the organic chemistry material, especially the Organic Chemistry Reactions course during their lectures, was still insufficient to equip them to teach organic chemistry at SMA/MA. This is an indicator of the ineffective implementation of the IQF integrated curriculum concept in learning. Based on this, it is necessary to update strategies, methods, models, and learning media so that the implementation of the IQF integrated curriculum concept can be carried out properly so that course learning outcomes (CP_MK) are achieved properly according to learning objectives. One of the media that is suitable for use in learning is project-based interactive teaching material media that can be developed into a project-based interactive e-Module teaching material with reference to the IQF integrated curriculum concept.

The use of project-based interactive e-Modules will motivate students to be more proactive in learning, because teaching materials can be accessed from the internet at certain times and conditions so that it is not difficult to learn. Interactive E-Modules are designed practically with links and learning flip videos, so as to attract student interest in learning and create new learning experiences. Likewise, lecturers can easily carry out learning activities even though they are in different places from students. E-learning media facilitates the teaching and learning process, by relying on the internet students become closer to learning, especially when distance learning is implemented (Mubarok et al., 2018). E-Modules are a medium for obtaining material effectively and students can learn according to their abilities and speed (Munthe et al., 2019; Setyorini et al., 2022; Mahmudah et al., 2022). The use of e-modules makes students interested in the learning process, and can be accessed at any time and in any condition, supported by adequate tools so that it is not difficult for students to use them (Istuningsih et al., 2018; Arfika et al., 2023; Rajagukguk et al., 2023). E-modules are used as learning tools by covering materials, methods, and learning evaluations, designed practically so as to attract student interest in learning (Belia et al., 2022).

E-Modules are self-instructional, only covering one learning material so that students focus on the material being taught. Adaptive because the development of e-modules is in accordance with the character of students (Muslih et al., 2022). In developing e-module media, learning models can be integrated by paying attention to their suitability, so that they can make it easier for students to learn (Rojiyyah et al., 2023). The development of electronic learning media can be carried out using the ADDIE method through the stages of analysis, design, development, implementation, and evaluation (Novira et al., 2022; Siregar and Silaban, 2023).

Project-based learning assisted by e-Module media is collaborative learning based on constructivist theory to achieve the ultimate goal of learning (Grant, 2011). This model is a dynamic learning approach, students actively explore real-world problems, provide challenges, and acquire deeper knowledge (George Lucas Educational Foundation, 2014). It has been recommended that equipping teachers with comprehensive knowledge in using new technologies and applying them in the classroom effectively is known as Teacher 4.0 (teachers of the future), who are able to use new technologies and apply them effectively in the classroom (Alam et al., 2022). Teachers are responsible for integrating technology in the education system, promoting inquiry, problem solving and students' critical thinking skills (Khosrow-Pour, 2014). E-Module media-assisted project-based learning has been widely used in Higher Education to improve the quality and effectiveness of teaching (Noris et al., 2023). Learning accompanied by project-based practice students will gain increased knowledge, skills and social responsibility in their groups (Derkach et al., 2023). Based on the research findings (Ali et al., 2013) it was reported that with project-based learning assisted by the e-Module, student achievement and learning activities can increase significantly.

Method

This type of research is educational research and development (Educational Research and Development), using the ADDIE method. This research was conducted at the Department of Chemistry, State University of Medan TA. 2023, referring to the Medan State University research strategic plan and the plan to implement the KDBK research in the Unimed Chemistry Study Program. The research stages started from needs analysis, curriculum analysis, analysis of teaching materials to be developed, design and development of interactive e-Modules, validation, revision several times to obtain standard interactive e-Modules products, one-on-one trials, small group trials and large group, implementation and evaluation, like the flowchart presented in Fig.-1.

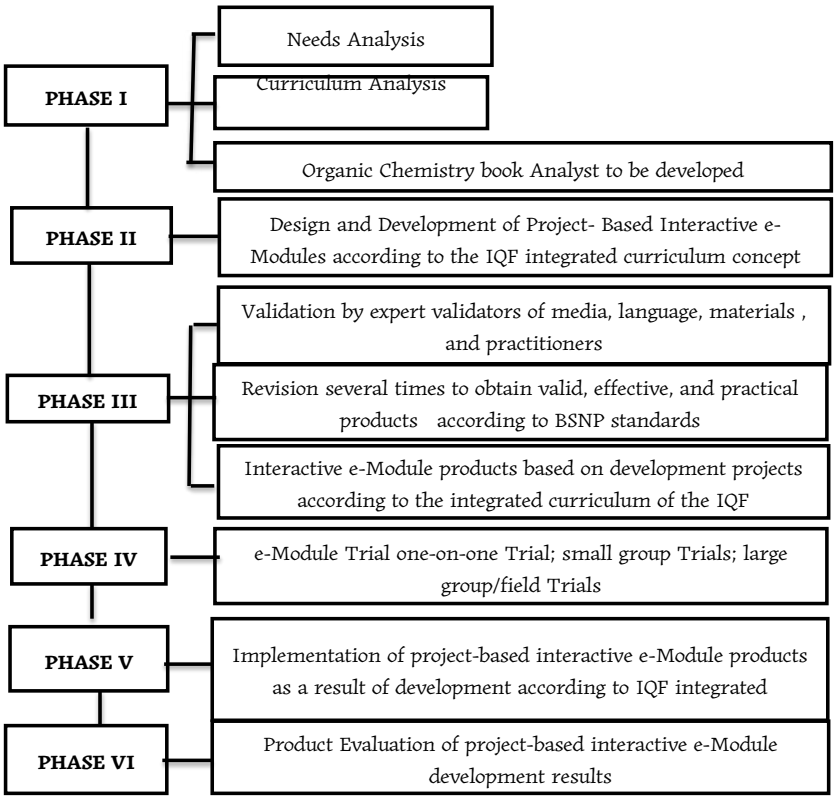

Fig.-1. Applied product research flowchart

Data Collection Instruments

The screening instruments and data collection techniques used in the study consisted of: validation questionnaire instruments, learning activity instruments, observation sheet instruments, student satisfaction response questionnaire instruments, learning achievement test instruments. All data collected is collected and distributed into distribution tables for analysis.

Data Analysis Technique

Analysis of the research data was carried out in a qualitative and quantitative descriptive manner on the validity and effectiveness of the interactive e-Module development results. Calculating the average value of validity, the average value of effectiveness, the average value of increasing student chemistry learning outcomes, the average percentage of student satisfaction levels in learning. Data were processed descriptively and analyzed using ANOVA statistical variance assisted by SPSS software.

Feasibility Analysis of Interactive e-Modules

The data analysis technique used to analyze validation data from lecturers and teachers is the average technique with the $\overline{X} = \frac{\Sigma X}{n}$; $\overline{X}$ = average value: ΣX/n = number of validator/test subject assessment answers; Σ X = number of validator/test subject assessment answers; n = number of validators/test subjects. The full range of validation criteria for calculations can be observed in the following Table 1.

Table 1. Average analysis validation criteria (Arikunto, 2013)

Average	Validation criteria
3.26 – 4.00	Very valid
2.51 – 3.25	Valid
1.76 – 2.50	Less valid (revised)
1.00 – 1.75	Invalid (total revision)

Analysis of Improved Learning Outcomes

To find out the increase in learning outcomes can be calculated by the g factor formula (normalized gain score). Percent increase in learning outcomes is calculated by: gain equal to the value of the posttest score minus the pretest score divided by the maximum score minus the pretest score with criteria: g < 0,3 = (Low) ; 0,3 ≤ g ≤ 0,7 = (Currently) ; g > 0,7 = (Tall).

Data Normality Test

The normality test uses the Chi Square test (x2) with the provisions: if Chi square (hit.) $\chi 2$ < Chi square (tab) at $\alpha = 0.05$, the sample is normally distributed.

Homogeneity Test

Homogenity test by calculating Fcount from the value of the largest variance divided by the smallest variance. If Fcount < Ftable at ($\alpha = 0.05$) (db= (n1-1)(n2-1)), then the data is homogeneous.

Hypothesis test

After the data is normally distributed and homogeneous, a hypothesis test is carried out with one-sided t test (right-hand test), with the criteria: if tcount > ttable at the real level ($\alpha = 0.05$) (db = n1 + n2 –2) then H (a) is accepted and H (o) is rejected.

Results and Discussion

Results of Preliminary Analysis of Organic Chemistry Teaching Materials from publishers A and B

Prior to carrying out research and development, an integrated curriculum analysis of IQF was first carried out and an analysis of organic chemistry teaching materials for publishers A and B to find out their strengths and weaknesses. ,21; linguist 3.02; material expert 3.11; and expert practitioners 3.25; Overall, the average value of content feasibility is 3.12; including valid criteria and does not need to be revised. For language eligibility, the average value of the media expert validator is 3.05; linguist 3.15; material expert 3.20; and expert practitioners 3.15; overall obtained 3.14; including valid criteria and does not need to be revised. For the feasibility of presenting the average value of the media expert validator 3.14; linguist 3.21; material experts 3.13; and expert practitioners 3.08; overall obtained 3.14; includes valid criteria and does not need to be revised. For graphic feasibility, the average value obtained from the media expert validator is 2.78; linguist 3.05; material experts 2.97; and expert practitioners 2.86; overall obtained 2.98; including valid criteria and does not need to be revised. Furthermore, the average final grade for organic chemistry teaching materials from publisher A was obtained at 3.08; meaning that it is in accordance with BSNP standards and is suitable for use by students in learning

Data from the validator's analysis of organic chemistry teaching materials from publisher B were obtained for content feasibility: the average score of the media expert validator was 2.94; linguist 2.85; material experts 2.78; and expert practitioners 2.86; overall obtained 2.89; including valid criteria and does not need to be revised. For language feasibility, the average value obtained from the media expert validator is 3.12; linguist 2.84; material experts 3.16; and expert practitioners 2.95; overall the average value obtained is 3.04; including valid criteria and does not need to be revised. For the feasibility of presentation, the average value obtained from media experts is 2.87; linguist 2.82; material experts 3.06; and expert practitioners 2.89; overall obtained 2.95; including valid criteria and does not need to be revised. Meanwhile, for graphic feasibility, the media expert validator obtained an average value of 2.68; linguist 2.94; material experts 2.86; and expert practitioners 2.67; overall obtained 2.77; including valid criteria and does not need to be revised. Overall, the average final score for Organic Chemistry teaching materials from publisher B was 2.90; meaning that it is in accordance with BSNP standards and is suitable for use by students in learning.

However, when viewed from the IQF integrated curriculum concept, organic chemistry teaching materials from publishers A and B still need to be revised by means of design and development into a teaching material in the form of project-based interactive e-Modules needed by students in the Organic Chemistry Reactions course, so that students can be more motivated to learn it. Weaknesses and deficiencies identified by the expert validator in teaching materials from publishers A and B, namely: Not yet containing the formulation of graduate learning outcomes (CPL) and course learning outcomes (CP_MK) according to the IQF integrated curriculum concept. Teaching materials A and B are not in online form so they cannot be accessed from the internet. Learning flip videos and links are not yet available. There is a lack of consistency between the sub-material and the subject matter, the presentation of the material is incomplete and there is no mini-research pilot project available according to the integrated curriculum concept of the IQF.

In the effort to develop project-based interactive e-Modules, the presentation of material needed in the organic chemistry reaction course will be made complete and consistent, CPL and CP_MK formulas will be included, learning is designed online with links available, has complete learning flip videos with links. There is a student worksheet (LKM). The order of the sub-material will be adjusted to the subject matter in the scope of material that is expanded with the availability of a laboratory experiment mini-research project, and is accompanied by examples of competency test questions and answer keys. The use of sentences in work procedures will be formulated in such a way as to be easily understood and not allow students to experience misconceptions.

Project-based interactive e-Module Teaching Material Development Results According to the IQF Integrated Curriculum Concept

The deficiencies obtained from the analysis of organic chemistry teaching materials from publishers A and B became the basis for the development of project-based interactive e-Module teaching materials with reference to the IQF integrated curriculum concept, so that BSNP standard teaching materials were produced and suitable for use by students in Organic Chemistry Reaction lectures. In the development stage of project-based interactive teaching materials complete with graduate learning outcomes (CPL) for the Organic Chemistry Reaction course, the course learning outcomes (CP_MK) include knowledge, general skills, specific skills and attitudes, instructions for using teaching materials and concept maps according to the integrated curriculum concept IQF.

The teaching materials developed are made into 7 (seven) parts of valid and effective interactive project-based e-Modules, standardized with BSNP, with the main sequence of materials: e-Module-1 the subject matter of Basic Concepts of Organic Chemical Reactions; e-Module-2 Addition Reaction; e-Module-3 Elimination Reaction; e-Module-4 Nucleophilic Substitution; e-Module-5 Enolate and Carbanion; e-Module-6 Electrophilic Substitution; and e-Module-7 on the subject of Free Radicals. All of them are designed and developed into an online project-based interactive e-Module teaching material with links, containing mini research pilot projects, learning flip videos accompanied by links, containing mini research pilot project assignments, competency test questions and answer keys, as well as student worksheets (MFI).

Results of the Validation of Interactive e-Module Teaching Materials Based on Development Results

Validation of interactive e-Module teaching materials as a result of development is carried out by giving a score to the questionnaire instrument for content feasibility, language, presentation, and graphic feasibility. Using a Likers scale with a score of 4 = strongly agree; score 3 = agree; score 2 = disagree; and score of 1 = strongly disagree.

The validation results obtained an average content feasibility value by the media expert validator of 3.92; linguist 3.91; material experts 3.84; and expert practitioners 3.85; overall the average value obtained is 3.88; including very valid criteria and does not need to be revised. For language feasibility, the average value obtained from media experts is 3.85; linguist 3.78; material experts 3.91; and expert practitioners 3.79; overall obtained an average value of 3.83; including very valid criteria and does not need to be revised. For the feasibility of presentation, the average value obtained from media experts is 3.72; linguist 3.73; material experts 3.83; and expert practitioners 3.76; overall obtained 3.76; including very valid criteria and does not need to be revised. Meanwhile, for graphic feasibility, the media experts obtained an average score of 3.80; linguist 3.68; material experts 3.81; and expert practitioners 3.81; overall obtained an average value of 3.78; including very valid criteria and does not need to be revised.

Overall, the average value of project-based interactive e-module teaching materials developed was 3.81, including very valid criteria. This means that it meets the BSNP standards according to the integrated curriculum concept of the IQF, and is suitable for use by students in learning the Organic Chemistry Reaction course.

Some of the Advantages and Advantages of Project-Based Interactive Teaching Materials Developed Results

Some of the advantages and advantages of teaching materials for Organic Chemistry Reaction in the form of project-based interactive e-Modules. the results of the development according to the IQF integrated curriculum concept, namely: CPL and CP_MK formulations have been included according to the IQF integrated curriculum concept. Designed online and has a link, so students can easily access it from the internet at any time and wherever it is used. Contains concept maps and instructions for using e-Modules, arranged sequentially based on the integrated curriculum concept of the IQF with the order of subjects for the Organic Chemistry Reactions course. All e-Modules starting from e-Modules 1 to 7 are made to have concept maps sequentially to help students understand the series of concepts in the organic chemical reactions material they are studying. Each e-Module contains course learning outcomes (CP_MK), both knowledge CP_MK, general skills CP_MK, specific skills CP_MK, and attitude CP_MK. The composition of the teaching materials has been adapted to the concept of the IQF integrated curriculum, each of which is equipped with a competency test and answer key.

All e-Modules have been equipped with learning flip videos along with their links, so that students will be more motivated to learn, because they can be accessed easily at any time and in certain situations and conditions. Presentation of material is arranged consistently between sub-material and subject matter, contains mini research laboratory experiments, contains competency tests along with answer keys, competency test questions in objective form and essays in the form of assignments for students to work on, contains experimental procedures, learning is designed online using video learning flip which students can easily access by clicking on the learning video links that are available for each e-Module, so that students will be more interactive and motivated to learn. The presentation is designed based on a mini research pilot project that is contained in a student worksheet (LKM). The use of sentences in work procedures has been made concise and clear so as not to allow students to experience misconceptions. The use of sentences is made concise and clear, practical so that students can easily understand it. The use of sentences has been adjusted with enhanced spelling (EYD). The front cover image is designed in such a way that it reflects the content of the presentation material, and the colors reflect bright rainbow colors according to the color of the content. The coloring has been adjusted to the colors of the rainbow to reflect the color of the content.

The following is comparative data validation results on organic chemistry teaching materials from publishers A and B with project-based interactive e-Module organic chemistry teaching materials developed as presented in Table 2.

Table-2. The average results of the validation values of teaching materials for publishers A and B and project-based interactive e-Module teaching materials as a result of development

No	BSNP criteria	The average value of the validator is a media expert, linguist, material expert, and practitioner expert		
		Publisher's teaching materials A	Publisher's teaching materials B	Developed e-Module teaching materials
1	Content Eligibility	3.12	2.83	3.88
2	Language Eligibility	3.14	3.04	3.83
3	Presentation Eligibility	3.14	2.95	3.76
4	Graphic Eligibility	2.92	2.77	3.78
	Average	3.08	2.90	3.81

Furthermore, it can be seen a comparison of the score graphs of the validation results of organic chemistry teaching materials from publishers A and B with project-based interactive e-Module teaching materials developed as shown in Fig.-2.

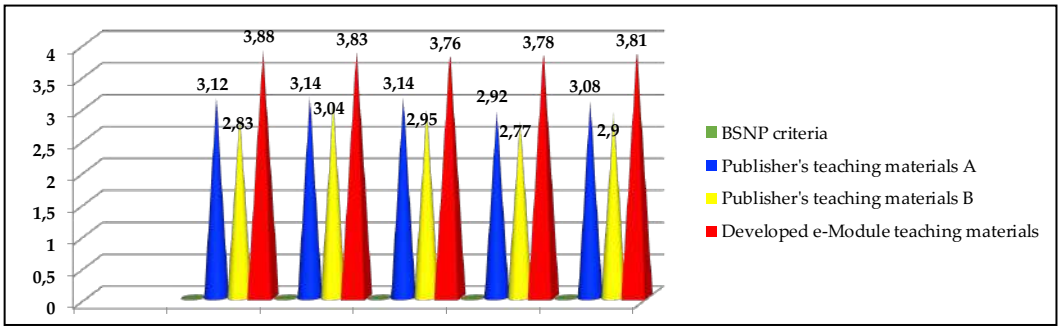

Fig.-2 Comparison of the average validation values of teaching materials A and B with interactive E-Modules based on project development results

Trial of Interactive e-Module Teaching Materials Based on Development Results

One-to-one trial results. The one-on-one trial involved 5 chemistry education students and 2 lecturers. Giving a feasibility score to the respondent's achievement level (TCR). done using the following formula: TCR (average score)/(ideal score) x 100%. In full, the results of one-on-one trials of project-based interactive e-Module teaching materials developed as a result of the development are presented in Table 3.

Table 3. The results of the one-on-one trial feasibility of project-based interactive e-Module teaching materials on the results of the development

No	Aspects of Assessment	Number of Indicators	Average TCR (%)	Category
A total of 2 Lecturers / Practitioners				
1	Instructional Media	4 Indicator	93%	Very worth it
2	Learning materials	6 Indicator	89%	Very worth it
3	Benefits of e-Module learning media	2 Indicator	95%	Very worth it
	Overall Average TCR		92.33%	Very worth it
A total of 5 students				
1	Instructional Media	4 Indicator	87%	Very worth it
2	Learning materials	6 Indicator	91%	Very worth it
3	Benefits of e-Module learning media	2 Indicator	89%	Very worth it
	Overall Average TCR		89%	Very worth it

Based on the data from Table 3, the results of one trial for the feasibility of project-based interactive e-Module teaching materials developed resulted in an average TCR of 2 lecturers of 92.33%, very decent category, and an average TCR of 5 students obtained 89%, very decent category. Overall, it was obtained 90.67%, the category was very feasible for students to use in learning the Organic Chemistry Reaction course.

Small group trial results. The results of the small group trial involved 10 chemistry education students. The details are presented in Table 4. Based on the data in Table 4, it is known that the results of the small group trials on the feasibility of project-based interactive e-Module teaching materials developed resulted in an average TCR of 92.33% in the very feasible category for students to use in learning the Organic Chemistry Reaction course.

Table 4. Results of small group trials on the feasibility of project-based interactive e-Module teaching materials developed

No	Aspects of Assessment	Number of Indicators	Average TCR (%)	Category
A total of 10 students of chemistry education				
1	Instructional Media	4 Indicator	91%	Very worth it
2	Learning materials	6 Indicator	93%	Very worth it
3	Benefits of e-Module learning media	2 Indicator	93%	Very worth it
	Overall Average TCR		92.33%	Very worth it

Results of large group trials. The results of the large group trial involved 45 chemistry education students. The details are presented in Table 5. Based on the data in Table-5, it can be seen that the results of the large group trials on the feasibility of project-based interactive e-Module teaching materials developed involving 45 students, obtained an average TCR of 94.33% in the very feasible category for students to use in learning the Organic Chemistry Reaction course.

Table 5. The results of the large group trial of the feasibility of project-based interactive e-Module teaching materials developed

No	Aspects of Assessment	Number of Indicators	Average TCR (%)	Category
A total of 45 students of chemistry education				
1	Instructional Media	4Indicator	93%	Very worth it
2	Learning materials	6 Indicator	95%	Very worth it
3	Benefits of e-Module learning media	2 Indicator	95%	Very worth it
	Overall Average TCR		94.33%	Very worth it

Test the Effectiveness of the Developed Interactive e-Module Teaching Materials

Effectiveness test results in small groups. Testing the effectiveness of small groups of interactive e-Module teaching materials can be seen from the N-gain test by calculating the difference in pre-test and post-test scores, with the formula: N-gain = (S post-test - S pre-test)/(S max - S pre-test) x 100. Then the average gain is calculated to conclude in the high, medium or low category, with an interval scale (gain < 0.3. low; 0.3 < gain ≥ 0.7 moderate; gain > 0 .7 high), then convert to a scale of 100.

The results of the effectiveness test in the small group obtained an average pretest score of 42.75 and 89.50 posttest. From the calculation, it was obtained an N-gain of 79.35, including in the high criteria, it can be stated that the developed project-based interactive e-Module teaching material product is included in the high effectiveness criteria (very effective). Then the normality and homogeneity tests were carried out using SPSS with the One-Sample Kolmogorov Smirnov Test analysis technique, at α 0.05. If sig. hits. (sig.) > α, then the data is normally distributed. Meanwhile, the homogeneity test with the One-Way Anova analysis technique is at the level of α.0.05. If sig.count (sig.) > α., then the data is homogeneous.

Based on the normality test data, the sig. post-test 0.077 and pre-test 0.015, while in Shapiro Wilk for post-test 0.073 and pre-test 0.003. Because of the sig hit value. > α, (0.077 > 0.05) then the data is normally distributed. Furthermore, the homogeneity test was carried out and the sig value data was obtained. for the post test of 0.06. Because sig. 0.06 > 0.05, the data is homogeneous. With the fulfillment of the two conditions for the parametric statistical test, a hypothesis test was carried out using a paired t-test. From the t-test, the Sig. 0.011. Because 0.011 < 0.05 or (sig < α) it can be concluded that there is a significant difference between the post-test and pretest learning outcomes. These results indicate that there is an increase in student learning outcomes before and after learning by 79.35%.

Effectiveness test results in large groups. In the large group trials, the average pretest score was 43.45 and the posttest average score was 89.78. From the calculation, an N-gain of 79.89 is included in the high criteria, so the developed project-based interactive e-Module teaching material product is stated in the high effectiveness criteria. (very effective). Then the data normality test was carried out and the sig value was obtained. post-test 0.077 and pre-test 0.15, while in Shapiro Wilk for post-test 0.073 and pre-test 0.003. Because the sig value > 0.05, the data is normally distributed. Furthermore, the data homogeneity test obtained a sig. Based on mean value for the post test of 0.06. Because sig. 0.06 > 0.05, the data is homogeneous. With the fulfillment of the two conditions for the parametric statistical test, a hypothesis test was carried out using the paired t-test formula. From the results of the t-test, the value of Sig. 0.011. Because 0.011 < 0.05 or (sig < α) it can be concluded that there is a significant difference between the post-test and pretest learning outcomes data. These results indicate that there is an increase in student learning outcomes before and after learning 79.89%.

Summary of data on improving learning outcomes in piloting interactive e-Module teaching materials based on development results in small groups and large groups is presented in Table 6.

Table 6. Summary of data on improving student chemistry learning outcomes

No	Sample	Mean Pre-test	Mean Post-test	N- gain
1	Small groups	42.75	89.50	79.35
2	Large groups	43.45	89.78	79.89

Based on the data in Table 6, the N-gain in the small group trial was 79.35, meaning that there was an increase in students' chemistry learning outcomes in the small group trial of 79.33%. Meanwhile for the large group, an N-gain of 79.89 was obtained, meaning that there was an increase in student chemistry learning outcomes in the large group trial of 79.89%. Graphically it can be seen as presented in Fig.-3.

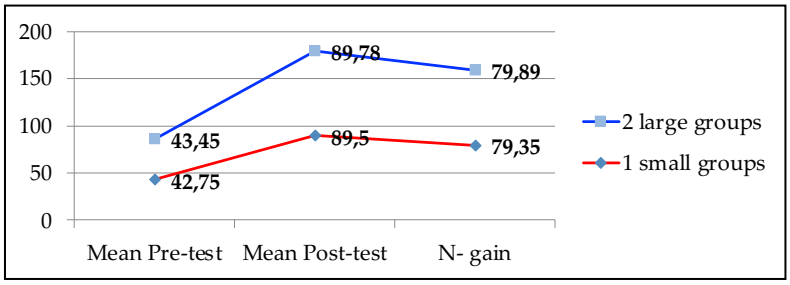

Fig.-3. Graph of increased learning outcomes in small and large group trials of interactive e-Module teaching materials based on development results

Research conducted by Nainggolan et al. (2020) shows that the effectiveness of using learning development products has a real effect on learning outcomes. Effectiveness in small group trials had an impact on student learning outcomes of (M=51.90%) in the moderate and effective category, large group trials of (M=59.62%) in the moderate and effective category, and in field trials (classical) has a real impact on student learning outcomes (M=70.41%) in the high and effective category.

Results of Perceptions of Student Satisfaction Levels for the Application of Interactive e-Module Teaching Materials based on Development Results

After students use project-based interactive e-Module teaching materials as a result of development in large group trials (field trials), a response questionnaire is given to determine the level of student satisfaction with the use of project-based interactive e-Modules in learning. Questionnaires were given to 45 students to provide responses to 30 items of questionnaire statement indicators. From the completed questionnaire, the amount of data acquisition and the percentage of perceptions of student satisfaction levels were calculated. It was obtained that the average percentage value of the perception of the level of student satisfaction with the project-based interactive e-Module teaching materials developed in learning ranged from 87.47% - 88.80% for each statement questionnaire, and overall the average percentage value was obtained student satisfaction of 88.19%. Based on these results it was concluded that students were satisfied with the use of project-based interactive e-Module teaching materials as a result of development in learning, and could better understand organic chemical reaction material. Meanwhile, the results of research by Nainggolan et al. (2021) which was carried out through the application of an innovative project-based learning model developed with an IQF-based curriculum orientation showed that students had a very good performance index of (M= 85.71%). In research shows that student competence in the field of Physical Organic Chemistry is very competent (M=92.4%). Student achievement in the cognitive domain was classified as good (90.8%), for the psychomotor domain (97.6%). Students' attitudes in learning activities have a significant impact on simultaneously increasing knowledge and skill competencies. Meanwhile, in research by (Nuha et al., 2020) it was stated that project-based learning is effective in developing students' skills and attitudes to improve their learning outcomes.

Student Performance Assessment Results

Evaluation of student performance was carried out by three observers using a performance assessment instrument, which was carried out during the process of working on a mini-research pilot project in the laboratory and making learning flip videos. Performance appraisal includes 3 (three) components; namely the pre-employment stage, the implementation of learning and the implementation of performance practices. The percentage of student performance scores in project work was obtained by an average percentage of student performance scores in planning and implementing project activities of 85.97%. Based on these results it can be concluded that the performance product of student project activities in learning is classified as good and shows the affordability of course learning achievement standards (CP-MK).

Conclusion

Teaching materials for Organic Chemical Reaction in the form of project-based interactive e-Modules developed online according to the integrated curriculum concept of the IQF are in very valid criteria, very feasible to use with an average respondent achievement rate (TCR) score of 92.44%, and in the criteria high effectiveness (very effective). The application of teaching materials for Organic Chemistry Reaction in the form of interactive e-

Modules based on development projects can improve student chemistry learning outcomes in small group trials of 79.33% and large group trials of 79.89% with an average increase in results learning 79.71%. Student perceptions of the use of project-based interactive e-Modules as a result of development are in the criteria of very satisfied with an average percentage score of 88.19%. Student project performance products are in the good category and show the affordability of course learning achievement standards (CP-MK).

Conflict of Interests

The author (s) declares that there is no conflict of interest in this research and manuscript.

Acknowledgment

Researchers would like to thank the Chancellor of Unimed and the Chairperson of the Institute for Research and Community Service for the assistance of Medan State University PNBP Funds for Fiscal Year 2023 No. 0137/UN33.8/KPT/PPT/2023.

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