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Development of E-Modules Based on Project Based Learning (PjBL) on Periodic System of Elements Material

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Abstract: Development of E-Learning Modules Based on Project Based Learning (PjBL) on Periodic System of Elements Material. This research was conducted in November 2023-February 2024 at SMAN 1 Percut Sei Tuan with the aim of finding out: (1) the feasibility of e-modules based on Project Based Learning (PjBL) on periodic system of elements material based on the BSNP assessment instrument consisting of content feasibility, appropriateness of presentation, appropriateness of language and appropriateness of graphics, (2) practicality of e-modules based on Project Based Learning (PjBL) on material periodic system of elements through responses from chemistry teachers and students. This research was carried out with Research and Development (Research and Development) using the 4D development model (define, design, develop, disseminate) which is limited to the develop stage. The initial stages carried out in this research were initial analysis, ATP analysis, and analysis of teaching materials. Then the design and creation of e-modules based on Project Based Learning (PjBL) were carried out on the material of the periodic system of elements. The final result of the e-module is converted into a flipbook with the help of the Flip PDF Professional application. Then the e-module was validated for its feasibility by 6 validators. After carrying out the feasibility validation stage and the revision or improvement stage, a practicality test was carried out through the responses of 2 chemistry teachers and 31 students. The results of the e-module feasibility percentage obtained in the research were content feasibility of 94%, presentation feasibility of 95%, language feasibility of 96%, and graphic feasibility of 85%, where the four assessments were included in the "very feasible" criteria. In the practicality test, the percentage obtained by the teacher was 96% and by the students it was obtained at 90%, with the criterion "very practical".

Keywords: *E-* Module, project based learning, periodic system of elements, feasibility, practicality.

Abstrak: Pengembangan E-Modul Pembelajaran Berbasis Project Based Learning (PjBL) pada Materi Sistem Periodik Unsur. *Penelitian ini dilakukan pada November 2023-Februari 2024 di SMAN 1 Percut Sei Tuan dengan tujuan untuk mengetahui: (1) kelayakan e-modul pembelajaran berbasis Project Based Learning (PjBL) pada materi sistem periodik unsur berdasarkan instrumen penilaian BSNP yang terdiri dari kelayakan isi, kelayakan penyajian, kelayakan bahasa dan kelayakan kegrafikan, (2) praktikalitas e-modul pembelajaran berbasis Project Based Learning (PjBL) pada materi sistem periodik unsur melalui respon guru kimia dan peserta didik. Penelitian ini dilakukan dengan Penelitian dan Pengembangan (Research and Development) menggunakan model pengembangan 4D (define, design, develop, disseminate) yang dibatasi sampai tahap develop. Tahap awal yang dilakukan dalam penelitian*

ini adalah analisis awal, analisis ATP, dan analisis bahan ajar. Kemudian dilakukan perancangan dan pembuatan e-modul pembelajaran berbasis Project Based Learning (PjBL) pada materi sistem periodik unsur. Hasil akhir e-modul diubah dalam bentuk flipbook berbantuan aplikasi Flip PDF Professional. Kemudian e-modul divalidasi kelayakannya oleh 6 orang validator. Setelah dilakukan tahap validasi kelayakan dan tahap revisi atau perbaikan, maka dilakukan uji praktikalitas melalui respon 2 orang guru kimia dan 31 orang peserta didik. Hasil persentase kelayakan e-modul yang diperoleh pada penelitian adalah pada kelayakan isi sebesar 94%, pada kelayakan penyajian sebesar 95%, pada kelayakan bahasa sebesar 96%, dan pada kelayakan kegrafikan sebesar 85%, dimana keempat penilaian tersebut termasuk dalam kriteria "sangat layak". Pada uji praktikalitas oleh guru diperoleh persentase sebesar 96% dan oleh peserta didik diperoleh sebesar 90%, dengan kriteria "sangat praktis".

Kata kunci: *E-Modul, project based learning, sistem periodik unsur, kelayakan, praktikalitas.*

▪ INTRODUCTION

Education is a vehicle or bridge for humans to be able to develop their potential through the learning they gain. The quality of education in Indonesia has recently become very worrying. This is due to several problems in the Indonesian education system which cause the low quality of education in Indonesia. One factor in the poor quality of education is changes in the curriculum. Changing the curriculum does not guarantee the quality of teaching. The curriculum which is the basis for teachers work will become less than optimal if it is continuously changed. There are many fundamental errors that create a gap between the goals of the education system and the realization of its field. Which ultimately means that all goals are not achieved and not completed properly (Fitri, 2021). The curriculum in Indonesia has undergone several changes and improvements (Ulinniam, et al., 2021). Now there is an independent curriculum as the new curriculum used in Indonesia. The independent curriculum has a changing impact on teachers and students, teachers are more flexible to be as creative in teaching as possible, and teachers know more about students' interests, talents, needs and abilities (Rahayu, et al., 2022). Chemistry is a science that is obtained and developed through experimentation, seeking answers to questions about how natural phenomena can occur. Therefore, it is necessary to master concepts and materials as well as apply chemistry in everyday life (Rahmatsyah, & Dwiningsih, 2021). One of the high school chemistry topics is the periodic system of elements. The concept of the periodic table of elements is characterized by the use of many chemical symbols related to everyday life. The material on the periodic system of elements is included in abstract concepts with concrete examples (Anipah, Fatah, & Syarpin, 2020). The aim of studying chemistry based on the content standards for SMA/MA chemistry subjects (Permendiknas RI Number 22, 2006) is so that students have the ability to understand the concepts, principles, laws and theories of chemistry as well as their interrelationships and applications to solve problems in everyday life and technology. However, in reality, students often experience difficulties in studying chemistry. The difficulties faced by students in studying chemistry are because the concepts in chemistry are abstract (Putra, 2017). Teaching and learning activities (KBM) are sometimes still considered routine activities that are oriented towards mastering theory and memorizing only lectures and practicing questions, they are considered to lack experimental learning activities or the application of scientific methods, this has an impact on students' scientific work skills being less honed. Teachers as educators play the role of being experts who convey knowledge to students (Hutasoit, 2021).

Therefore, teachers should present media in every learning process in order to achieve learning objectives and students become more active in the teaching and learning process (KBM) (Muthoharoh, 2017). Learning resources are an important factor in improving the quality of learning. Learning resources include messages (all information in the form of ideas, facts and data conveyed to students), personnel (people who act as presenters and message processors, such as teachers, resource-rich personnel, and participants in learning activities), materials (software), tools (hardware used to convey messages), technology (environmental processes (conditions or circumstances in which learning activities occur) used to present messages) and environment (conditions or circumstances in which learning activities occur). An electronic module or commonly called an electronic module (e-module) is a set of non-print or softcopy digital learning media that is assembled systematically and can be used independently by students so that they solve problems in their own way (Rahmatsyah & Dwiningsih, 2021). According to Wulandari, Yogica, & Darussyamsu (2022), in the e-module, explanations of the material presented are also equipped with videos and practice questions that are designed interactively. Efforts that can be made to make learning more effective are using interesting teaching materials in the form of innovative modules. Learning innovation that can be carried out in e-modules is by using learning models and media. One model that can be applied to e-modules is the Project Based Learning model. Project Based Learning (project-based learning) or abbreviated as PjBL is a learning model that uses projects as the core of learning (Siregar & Harahap, 2020). In implementing the independent curriculum, every activity must produce a project (Rahayu, et al., 2022). Project-based learning is an approach that is very suitable for achieving more long-lasting and contextual results for students and having a learning environment that supports collaboration and creativity (Gary, 2015). This is in line with Purba's research (2020), the use of project-based learning modules on acid-base material can improve student learning outcomes (above the KKM). Based on the results of observations carried out at SMAN 1 Percut Sei Tuan, it is known that the school has entered the Independent Curriculum and the fact is that there are limited or inadequate teaching materials. The learning carried out is also teacher-centered (Teacher Learning Center) not student-centered (Student Learning Center). Thus, the learning outcomes of most class X students in the Periodic System of Elements material did not reach the Learning Objective Achievement Criteria (KKTP).

▪ METHOD

The type of research used in this research is development research or Research and Development (R & D) oriented towards the development of e-modules based on Project Based Learning on SPU material using a 4D development model which is limited to the Develop stage (Define, Design and Develop). The 4D development model consists of the define, design , develop and disseminate stages (Mufida, Subandowo & Gunawan, 2022). This research was carried out from November to February of the 2023/2024 academic year at SMAN 1 Percut Sei Tuan. The subjects in this research are validators. The object of this research is the e-module that will be developed, namely a Project Based Learning (PjBL) based learning e-module on the Periodic System of Elements material. In this research, there are two types of research data used, namely data, namely interviews (qualitative) and questionnaires (quantitative). The instruments used in the research are, the PjBL-based e-module feasibility validation instrument based on the BSNP assessment and the teacher and student response questionnaire

instrument used at the end of the development research. This instrument aims to assess the practicality of PjBL-based e-modules on the Periodic System of Elements material. Both instruments were prepared using a 1-4 Likert scale, namely, Strongly Agree (SS), Agree (S), Disagree (TS), Strongly Disagree (STS).

The research procedure carried out began with the define stage with initial analysis through interviews with class X chemistry teachers and analysis of students' needs for teaching materials. Then proceed with ATP analysis and analysis of teaching materials (books). At the design stage, the e-module draft is prepared to facilitate the completion of the e-module creation as a whole, selecting the e-module creation media. After that, the e-module was created. At the develop stage, validation of material suitability and media suitability is carried out, consisting of content suitability, presentation suitability, language suitability and graphic suitability. After that, revisions or improvements are made based on the validator's suggestions. After that, it was continued with a practicality test by chemistry teachers and students to assess the practicality of the e-module. Data obtained from the validation results of material feasibility, media feasibility and practicality are calculated using the formula:

$P = \frac{n}{N} x\ 100\%$

Information:

P = Percentage score in percent (%)

n = Number of scores obtained

N = Maximum number of scores

The percentage of validity scores for e-module feasibility and the percentage of practicality can be seen in Table 1 and Table 2.

Table 1. Percentage of Feasibility of PjBL Based E-Modules

Score Percentage (%)	Feasibility Criteria
81-100	Very Feasible
61-80	Feasible
41-60	Decent Feasible
21-40	Less Feasible
0-20	Not feasible

Table 2. Percentage of Practicality

Score Percentage (%)	Practicality Criteria
81-100	Very Practical
61-80	Practical
41-60	Decent Practical
21-40	Less Practical
0-20	Impractical

(Putra, et al., 2020).

▪ RESULTS AND DISCUSSION

This research produces a Project Based Learning (PjBL) based learning e-module on the Periodic System of Elements material which is equipped with material sub-chapters, learning videos, projects, worksheets and evaluation questions.

Define

Based on interviews that have been conducted, chemistry learning is still teacher-centred, this is because students are less active during learning. Apart from that, the problem experienced in learning chemistry is the low interest of students in studying chemistry, so that the majority of students do not reach the Learning Goal Achievement Criteria score (KKTP = 70) in SPU material. One of the factors that causes this to happen is that the teaching materials used by chemistry teachers are inadequate due to incomplete explanations of the material. Based on the needs questionnaire that was distributed to students, the results showed that 31.3% of students experienced difficulty in studying SPU material and 65.6% of students felt that it was sometimes difficult to learn SPU material. Then an ATP analysis is carried out to determine the elements of learning outcomes (CP), the preparation of learning objectives (TP) and the learning flow specifically for SPU material and continued with book analysis based on the BSNP assessment and analyzing the advantages and disadvantages of the book which is devoted to the topic or material of the Periodic System Elements assessed are based on the appearance or design of the book, the completeness of the discussion of the material, the connection of the material with daily life, supporting pictures and tables, and project activities.

Design

This stage begins with preparing a draft e-module which is carried out by planning and compiling learning materials for the Periodic System of Elements to achieve the learning objectives that have been prepared. The e-module draft is prepared based on the Learning Objectives Flow (ATP) used at the high school level, especially class The designed e-module must look attractive so that relevant media is needed to optimize the creation of the e-module. The programs/media that can be used in making this e-module are Microsoft Word (designing the contents of the e-module), Canva (designing the front and back cover of the e-module), I LOVE PDF (combining the cover and contents of the e-module) and Flip PDF Professional (designs e-modules into flipbooks and adds learning videos). Flip PDF Professional is an interactive media that can be used to design books or modules in electronic form and can be flipped back and forth when reading them. With just a drop or click, users can insert YouTube videos accompanied by links, hyperlinks, images, audio, flash and animated text (Khairinal, Suratno, & Aftiani, 2021). Then the e-module creation stage is carried out which is arranged with components in the form of an initial part consisting of the front cover of the e -module, foreword, table of contents, e-module identity (in which there are initial competencies, Pancasila student profile, infrastructure, target participants students, learning achievement learning model, learning objectives, meaningful understanding and trigger questions), e- module description, instructions for using the e -module, concept map and introduction to SPU material. The contents of the e -module include SPU sub-material, sample questions, practice questions, chemistry figures, notes, chemistry info, learning and practical videos, projects, LKPD, summaries and learning achievement tests. The final part of the e-module consists of an answer key, achievement assessment, reflection, glossary, index, bibliography, author biography and back cover of the e-module.

Develop

The development stage in this research consists of validating the feasibility of the e-module that has been developed by material expert validators and media expert validators (Ernica & Hardeli, 2019), revising the e-module and assessing the response of chemistry teachers and students to the e-module that has been validated eligibility. Arif & Mukhaiyar (2020), stated that the validation test stage of the product that has been developed aims to determine its feasibility based on the assessment of material experts and media experts. The assessment questionnaire used in validating this e-module is the National Education Standards Board (BSNP) assessment instrument. Validation carried out based on the BSNP assessment instrument consists of appropriateness of content, appropriateness of language, appropriateness of presentation, and appropriateness of graphics (Purba & Siregar, 2020). Validation of the suitability of the material in Project Based Learning (PjBL) based learning e-modules aims to determine the suitability of the e-module, namely the suitability of the content, the suitability of the language, and the suitability of the presentation. The validators in material assessment consist of 1 lecturer and 2 teachers. The calculation of the results of the material feasibility validation assessment can be seen in Table 3.

Table 3. Material Feasibility Validation Results

Assessment Aspects	Average Rating Percentage Validator			% Average	Feasibility Criteria
	D1	G1	G2		
Feasibility of content	94%	94%	96%	94%	Very feasible
Feasibility of presentation	98%	98%	90%	95%	Very worthy
Feasibility of language	100%	100%	89%	96%	Very worthy
% Average	97%	97%	91%	95%	Very worthy

The Project Based Learning (PjBL) based e-module material assessment diagram can be seen in Figure 1.

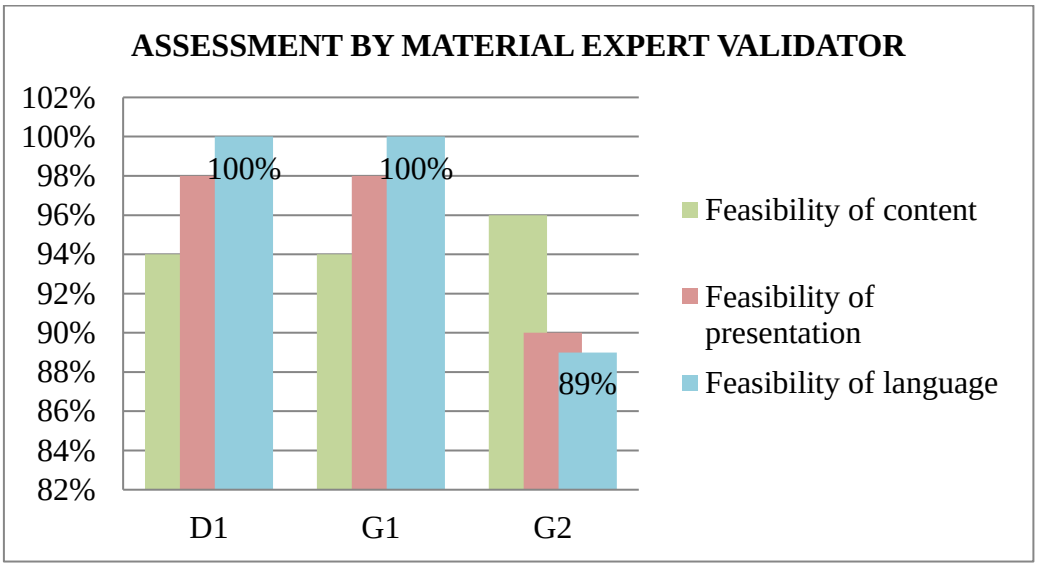

Figure 1. Assessment diagram by material expert validator

Based on the data in Table 4.2, you can see the percentage of material expert validator assessments of Project Based Learning (PjBL) based e-modules on periodic system of elements material. The average content feasibility assessment percentage is 94% and is included in the "very feasible" eligibility criteria. The average percentage of presentation feasibility assessments is 95% and is included in the "very feasible" eligibility criteria. The average percentage of presentation feasibility assessments is 95% and is included in the "very feasible" eligibility criteria. So that the average percentage of all assessments from all validators is 95% with the eligibility criteria being "very feasible".

The feasibility of e-module media based on Project Based Learning (PjBL) was carried out by expert media validators consisting of 3 lecturers. The calculation of the media suitability validation assessment results can be seen in Table 4.

Table 4. Media Feasibility Validation Results

Assessment Aspects	Average Rating Percentage Validator			% Average	Feasibility Criteria
	D1	D2	D3		
Graphic feasibility	96%	84%	75%	85%	Very feasible

The assessment diagram by media expert validators can be seen in Figure 2.

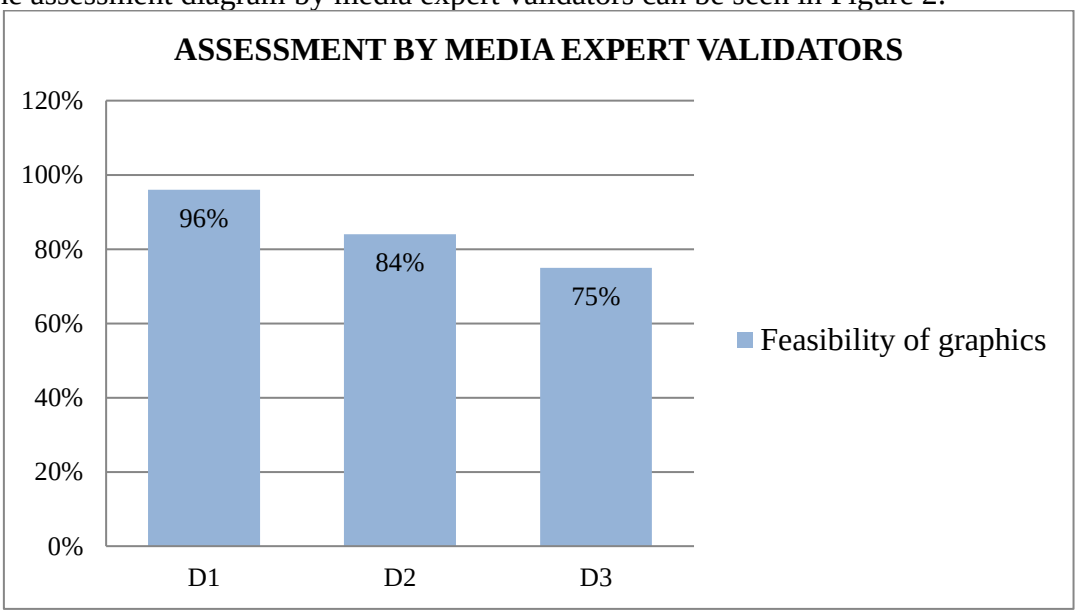

Figure 2. Rating diagram by media expert validators

The percentage of assessment of graphic feasibility by validator D1 was 96%, by validator D2 it was 84% and by validator D3 it was 75%. So the average percentage of graphic assessment obtained is 85% with the eligibility criteria being "very feasible".

The material feasibility results were obtained without any revisions, while the media feasibility results contained several revisions in the form of, correcting several inactive table of contents items, making the concept map more interactive (navigation

with hyperlinks), removing project work procedures so that students are more independent in designing and compiling procedures, project work, correcting incorrect word writing and reducing e-module background contrast.

After that, a practicality test was carried out consisting of the responses of 2 chemistry teachers and the responses of 31 students. The practicality test was carried out with the aim of determining the level of practicality of the e-module (Mahadiraja & Syamsuarnis, 2020). To test the practical value of e-modules, a practicality assessment can be carried out through a practicality sheet (Yanidah & Ratu, 2021). The assessment response questionnaire consists of 15 statements consisting of interest assessment, material assessment and e-module language assessment. Data on chemistry teacher responses can be seen in Table 5.

Table 5. Data from Teacher Assessment Response Results

Assessment Aspects	Average Rating Percentage		% Average	Practicality Criteria
	G1	G2		
Interest	96%	92%	94%	Very practical
Material	96%	92%	94%	Very practical
Language	100%	100%	100%	Very practical
% Average	97%	94%	96%	Very practical

The Project Based Learning (PjBL) based e-module chemistry teachers assessment diagram can be seen in Figure 3.

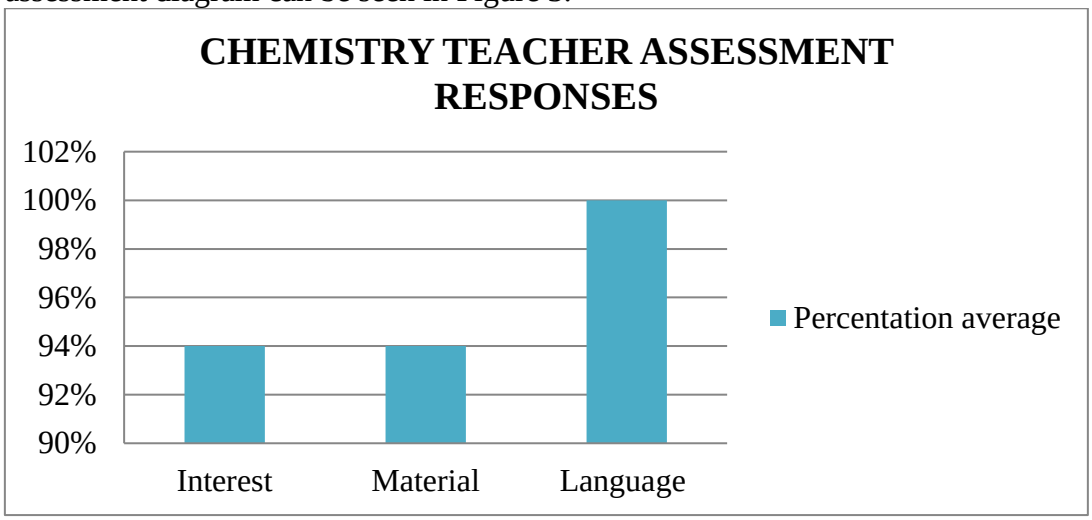

Figure 3. Chemistry teacher assessment response diagram

Based on the data in Table 5, it can be seen that the average percentage of assessments in the interest assessment aspect is 94% and the practicality criterion is "very practical". In the material assessment aspect, the average percentage is 94% and the criteria are "very practical". In the language assessment aspect, an average percentage of 100% was obtained with the criterion "very practical". So the average

percent of all aspects of the assessment by G1 and G2 was obtained at 96% with the practicality criterion being "very practical".

31 students responding to the e-module assessment. Data on student responses can be seen in Table 6.

Table 6. Data from Student Assessment Response Results

Assessment Aspects	Average Rating Percentage	Practicality Criteria
Interest	89%	Very practical
Material	86%	Very practical
Language	94%	Very practical
% Average	90%	Very practical

The Project Based Learning (PjBL) based e-module students assessment diagram can be seen in Figure 4.

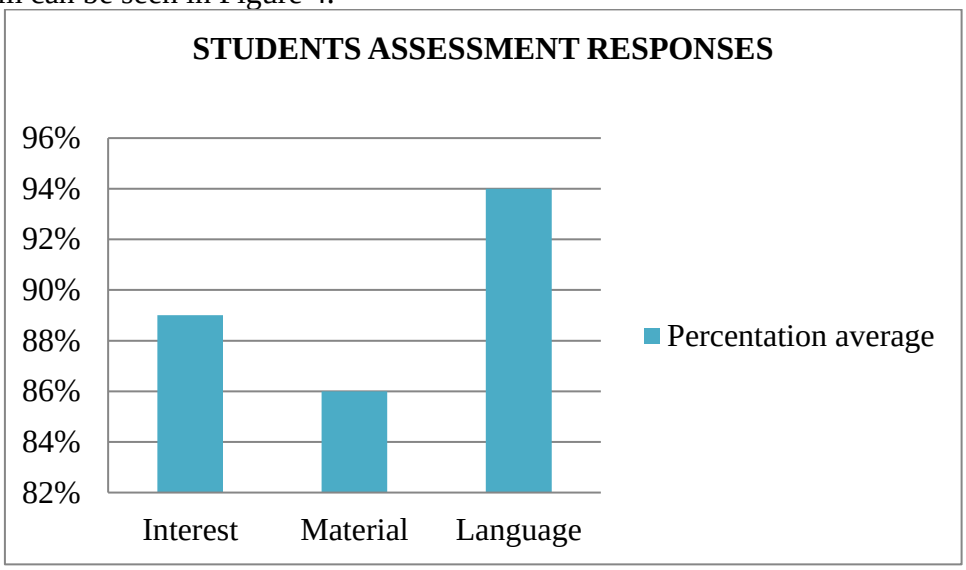

Figure 4. Students assessment response diagram

Based on the data in Table 6, you can see the average percentage of assessments and the practicality criteria for student assessment responses. In the interest assessment aspect, the average assessment percentage obtained was 89% with the practicality criterion being "very practical". In the material assessment aspect, the average assessment percentage was 86% with the criterion "very practical". In the language assessment aspect, an average assessment percentage of 94% was obtained with the criterion "very practical". So an overall average rating of 90% was obtained with the criteria "very practical". This is in line with Pazlina & Usmeldi (2020), analysis of data on the practical effectiveness of e-modules which is calculated using a percentage formula, the e-module category is effective if classical completeness is equal to or more than 85%, with a range of 81-100% in the category "very practical".

Thus, based on feasibility validation by material experts and media experts as well as the practicality of e-modules through assessment responses by chemistry teachers and students regarding e-modules based on Project Based Learning (PjBL), it can be seen that e-modules are based on Project Based Learning (PjBL). on material on

the periodic system of elements, it is very feasible and very practical to be used in studying chemistry on material on the periodic system of elements.

▪ CONCLUSION

Based on the research results, it can be concluded that the feasibility of e-modules based on Project Based Learning (PjBL) on the Periodic System of Elements material developed with BSNP standards is 94% content appropriateness with the feasibility criteria "very feasible", presentation feasibility is 95% with the feasibility criteria "very feasible", the language feasibility is 96% with the "very feasible" eligibility criteria and the graphic feasibility is 85% with the "very feasible" eligibility criteria. The practicality of e-module learning based on Project Based Learning (PjBL) on the Periodic System of Elements material through teacher responses of 96% with the practicality criterion of "very practical" and by students of 90% with the practicality criterion of "very practical".

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