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Development of Learning Devices Based on Ethnoscience Project Based Learning to Improve Students' Critical Thinking Skills

Luthfia Hanum*[1], Muhammad Hasan[2], Andi Ulfa Tenri Pada[3], Hafnati Rahmatan[3], Ratu Fazlia Inda Rahmayani[2], Elisa[4], Yusrizal[4]

[1]Study Program of Master Science Education, Graduate Program, Universitas Syiah Kuala, Banda Aceh, Indonesia
[2]Department of Chemistry Education, Faculty of Teacher Training and Education, Universitas Syiah Kuala, Banda Aceh, Indonesia
[3]Department of Biology Education, Faculty of Teacher Training and Education, Universitas Syiah Kuala, Banda Aceh, Indonesia
[4]Department of Physical Education, Faculty of Teacher Training and Education, Universitas Syiah Kuala, Banda Aceh, Indonesia

*Email: Luthfiahanum98@gmail.com

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Abstract. One of the causes of the low critical thinking skills of participants is caused by the learning process that focuses on mastering concepts alone without involving students to construct knowledge independently. Less comprehensive learning tools are the main obstacles that are often encountered in the implementation of learning. Project based learning is a constructivist method that is able to involve students to construct knowledge empirically, one of which is by utilizing the content of ethnoscience as a contextual approach in project learning. This study aims to develop a quality ethnoscience-based Project based learning devices in terms of content validity and empirical validity. This study uses the research and development method with the ADDIE model. The research was conducted at SMA Negeri 1 Gandapura. The research instrument used a validation sheet, student response questionnaires and teacher response questionnaires. Data analysis used the Aiken V coefficient for critical thinking skills test questions; Interclass correlation coefficient for lesson plans, Student Worksheets and Handouts; percentage formula for teacher and student response questionnaires. The results showed that the ethnoscience-based Project based learning devices were categorized as very feasible and could improve the critical thinking skills of students with an N-gain of 0.88 which was classified as high, and received a positive response from the teacher with a percentage of 96.71% and students by 86.35%.
Keywords: PjBL, Ethnoscience, Learning Devices, Critical Thinking Skills

Introduction

The prototype curriculum is designed as a new paradigm in the education system that is oriented towards the development of soft skills and student character (Puslitjakdikbud, 2021). Critical thinking skills are one of the 21st century competencies that are still focused on and included in science learning (Prafitasari, et al., 2021). Students are expected to be able to respond to changes quickly and effectively using rational intellectual skills and utilizing relevant information to find solutions to a problem (Al

Marwani, 2020; Nadeak, et al., 2020). Critical thinking skills need to be mastered by students as a life skill (life skills) to be able to survive and adapt to future situations and be sensitive to the surrounding environment (Bellaera et al., 2021). Thinking skills can support students' academic success and career opportunities (Hart et al., 2021).

Problems that often arise in the learning process, namely the delivery of teachers are often focused on mastering concepts or theories, resulting in less systematic development of students' thinking. PISA reports that the critical thinking skills of Indonesian students are still below the average of other countries. The 2018 PISA results show the fact that Indonesia is ranked 72 out of 77 countries evaluated with scientific ability, which has decreased the score from 403 to 396 points (OECD, 2019). This situation illustrates that there is a need for improvement in the learning process, especially in an effort to improve critical thinking skills. A review of the National Examination data shows that the critical thinking skills of Acehnese students in chemistry learning, especially in Bireuen district, are still relatively low with the 2018/2019 academic year chemistry test score of 39.23 which is below the national standard of 50.29. The percentage of the overall score of the material being tested is still relatively low or 55.00. Organic chemistry is one of the materials that is tested every year in the implementation of the National Examination, from several indicators tested, students still have difficulty in classifying the class of carbohydrate compounds based on the test; determine the structural formula, nomenclature, properties and uses of macromolecular compounds and determine statements related to the chemical properties of 2 carbon compounds based on the 2 structural formulas of their compounds (Puspendik, 2019). The concept of macromolecules emphasizes the analysis of the structure, nomenclature, properties, classification and manufacture of macromolecular products. This material is theoretical and seems abstract (Saragih et al., 2021), so contextual reinforcement is needed for concepts that are seen by students as symbolic, complex and abstract (Cardellini, 2012).

The results of an initial review at SMAN 1 Gandapura in January 2022, obtained information that students' critical thinking skills are still relatively low. This is reviewed through the acquisition of UNBK or UNKP scores of SMAN 1 Gandapura for the last 3 years in 2017, 2018, and 2019 respectively, obtained 33.33, 28.78 and 35.00. The PAS 2020 and 2021 scores respectively obtained an average of 58 and 67 for chemistry which is still below the minimum completeness criteria (KKM), which is 75. Based on the initial needs analysis of the researcher, it is known that the learning instruments owned by chemistry teachers are complete and in accordance with the direction of the educational curriculum. However, there are some weaknesses in the preparation of learning tools including, the available learning tools still do not pay attention to or facilitate critical thinking skills. The learning model contained in the lesson plans is relatively the same in each meeting. Classroom management is still done conventionally so that interaction between students is limited. The learning resources used only contain a summary of the material and evaluation questions have not been presented in the form of problems that can be solved in the form of activities by students. Teachers also have not used interactive worksheets so it is difficult to focus the attention of students. The teacher also explained that to provide worksheets as teaching materials it is still difficult to do because of the limited time and material being taught. In addition, the aspect of thinking skills has not become a special concern in learning because it is still focused on mastery of learning outcomes as a priority.

Based on these problems, innovation in the chemistry learning process is needed. One of the efforts to improve the quality of learning is by developing learning tools that can train students' critical thinking skills in connecting concepts and maximizing the potential of the environment, as a learning resource that allows students to gain meaningful learning experiences (Ratnasari, et al., 2020). Project based learning (PjBL) is a learning method that can improve critical thinking skills through the completion of a series of complex tasks containing life problem situations and practices (Chiu, 2020; Issa, et al.,

2021). PjBL involves students to actively construct knowledge that is not transmitted directly by the teacher (Guo et al., 2020; Rio et al., 2022). Students can organize learning activities and group discussions through the process of finding information, designing projects and presenting the results of projects that have been completed (Chen, et al., 2019; Almulla, 2020). Research shows that PjBL has a positive effect on students' innovative thinking skills (Barak, et al., 2021). PjBL has succeeded in supporting the improvement of students' thinking and social skills (Ruslan et al., 2021).

The low critical thinking skills of students can also be overcome by providing contextual learning so that students can be involved in connecting their knowledge and ideas of cognitive structures with new information obtained (Sholahuddin et al., 2021). Efforts have been made to integrate ethnoscience as an approach to learning materials (Dewi, et al., 2019). The relevance of ethnoscience and education is seen as an effort to bridge the preconceptions of students from various cultural backgrounds that lead to an understanding of modern science (Abonyi, et al., 2014; Suciyati, et al., 2021). The integration of chemistry and the context of local wisdom has not been widely practiced by teachers, especially in the province of Aceh, in fact Aceh has cultural diversity that can be internalized into learning content, such as in the field of herbal medicine, appropriate technology, additives and traditional food products. Research conducted by Kasi et al. (2021) shows that the frequency of studies ethnoscience in Aceh is still low compared to other parts of Indonesia. Research conducted by Zidny et al. (2020) shows that reinforcing ethnoscience in chemistry learning has a positive impact on problem solving skills and enriches students' insights about science in various perspectives in responding to sustainable issues and topics. element Local wisdom as a pedagogical context can improve student achievement and learning motivation (Onwu et al., 2020). The purpose of this study was to produce a proper ethnoscience-based PjBL device in terms of content validity and empirical validity. This development is expected to be able to help students to construct knowledge independently through project learning that contains local wisdom content so that they get feedback in improving critical thinking skills.

Methods

The type of research conducted is research and development. The research is located at SMA Negeri 1 Gandapura involving 33 students of class XII science in the 2021/2022 academic year. The development of Ethnoscience-based PjBL Learning devices uses the ADDIE development model which consists of 5 stages, namely analysis, design, development, implementation and evaluation (Branch, 2009; Uzunboylu, et al., 2017). The analysis phase begins with identifying the problem and collecting information about the learning tools in the school. At this stage, a needs analysis is carried out to analyze the state or condition of the available learning tools and determine what kind of learning materials need to be developed to help develop students' critical thinking skills. the next stage is an analysis by identifying competency standards and basic competencies related to the concept of macromolecules and determining indicators that will be used as the basis for developing learning tools. The researcher also conducts student analysis which aims to determine the characteristics of students who will take part in learning using the developed product. The characteristics of the students studied included background, previous learning experiences and attitudes towards the previous material.

The design phase is carried out by designing a conceptual framework regarding components and content that will be included in the lesson plan, student worksheets, macromolecule handout and critical thinking skills tests. The critical thinking test questions were developed using Ennis (2011). The combination of learning indicators and indicators of Ennis' critical thinking skills will be used as indicators in each item that will be developed.

The questions are presented in a description of 15 items that contain the context of Aceh's local wisdom. The researcher also developed a scoring guideline to convey the highest rating by using a holistic scoring guideline starting from 0 points as the lowest score to 3 points as a score. The development stage is carried out by realizing the design into a learning device product. The developed product is then consulted with the supervisor and followed by a validation process by experts (expert judgment) to assess the validity of the content/content of the learning device components. Product revisions are carried out based on inputs suggested by experts. Validation is carried out until the device is declared feasible to be implemented in learning activities. The implementation phase was carried out by conducting a direct trial of the Ethnoscience based PjBL devices at SMA Negeri 1 Gandapura in class XII IPA which opened 33 students. At the implementation stage, the researcher used a one group pretest posttest design. The aim is to find out the improvement of students' critical thinking skills after learning activities using the developed product. The evaluation stage (evaluation) is carried out by analyzing the assessments of teachers and students of learning devices based on the answers given to the empirical response questionnaire as a condition of validity. Analysis of improving critical thinking skills is a consideration in determining the location of ethnoscience based PjBL learning.

The instruments used are learning device validation sheets, student response questionnaires and teacher response questionnaires. The research data collection was carried out by submitting a validation sheet to the expert to assess the components of the learning device consisting of lesson plans, worksheets, handouts and critical thinking skills test questions. Questionnaires were given to teachers and students after the learning process took place. The data obtained were analyzed using qualitative descriptive to obtain conclusions about the feasibility of the learning tools that have been developed. The scores obtained from the validator's assessment were analyzed to determine the level of validity of the lesson plans, worksheets and handouts based on the criteria shown in table.

Table 1. Criteria Assessment Content Validity of Learning Devices

No	Interval	Kategori
1	$\geq 5{,}25$	Very Valid
2	$3{,}75 \leq X < 5{,}25$	Valid
3	$2{,}25 \leq X < 3{,}75$	Quite Valid
4	$0{,}75 \leq X < 2{,}25$	Less Valid
5	$\leq 0{,}75$	Not Valid

(Source: Yusrizal & Rahmawati, 2020)

Reliability testing of learning device components that have been assessed by expert judgment (agreement between raters) is then analyzed using the ICC with the following equation estimation (Shrout, et al., 1979):

$$\boldsymbol{\rho} = \frac{\boldsymbol{MSrs - MSe}}{\boldsymbol{MSr + (k-1)MSe}} \qquad (1)$$

Keterangan:

MSrs : Mean of the squares between raters

MSe : Error score variance

k : Number of raters

Table 2. Interpretation Interclass Corelation Coeffisient

No	Nilai ICC	Interpretasi
1	0.00 – 0.50	Poor Reliability
2	0.51 – 0.75	Moderate Reliablity
3	0.76 – 0.80	Good Reliability
4	0.81 – 1.00	Excellent Reliability

(Source: Portney, et al., 2009)

Analysis of the content validity of critical thinking skills test questions assessed by 3 expert judgments using the Aiken V coefficient with the following formula (Aiken, 1985):

$$\boldsymbol{V} = \frac{\sum \boldsymbol{s}\,(\boldsymbol{r}-\boldsymbol{l_0})}{\boldsymbol{n}\,(\boldsymbol{c}-\boldsymbol{1})} \qquad (2)$$

Keterangan:

V : Average overall vaidation

$\sum \boldsymbol{s}$: The sum of the rater deductions minus the lowest score

r : The number given by the rater

l_0 : The lowest validity rating score

c : The highest validity rating score

n : Number of raters

The criteria for determining the level of validity of critical thinking skills test questions can be seen in Table 3.

Table 3. Criteria Content Validation Index Aiken V

No	Interval	Kriteria
1	CVI< 0,4	Poor Validity
2	0,4 ≤ CVI< 0,8	Moderate Validity
3	CVI ≥ 0,8	High Validity

(Source : Mamonto et al.,2021)

Analysis of teacher and student responses was carried out by giving questionnaires to respondents and then analyzed using the percentage formula. The results of the calculation of the respondent's response score are calculated using the standards based on Table 4.

Table 4. Interpretation Score Percentage

No	Interval (%)	Keterangan
1	81 < I ≤ 100	Very good
2	61 < I ≤ 81	good

3	41 < I ≤ 61	quite
4	21 < I ≤ 41	Less
5	0 < I ≤ 21	Not good

(Source: Hidayah, et al., 2018)

Results and Discussion

Content Validity Results

The validity of the content of ethnoscience-based PjBL learning tools was carried out by three experts (expert judgments) before being tested or implemented in schools. Validity is carried out to produce learning device products that are valid and suitable for use. The description of the results of the content validation is interpreted as follows

Lesson Plan Validity Results

Lesson plan assessment consists of five feasibility tests including: (a) completeness of lesson plan identity; (b) formulation of learning objectives and indicators; (c) selection of learning models and approaches; (d) selection of learning resources and (e) language. The following recapitulation of lesson plan validation results can be seen in Table 5.

Table 5. Results of Ethnoscience-based PjBL Lesson Plan Validation by expert

No	Component	raters			Average	Rating Match
		V1	V2	V3		
1	Completeness of lesson plan identity	5	4.5	4.5	4.67	93.33
2	Formulation of learning objectives and indicators	5	4.8	4.6	4.80	96.00
3	selection of learning models and approaches	4.8	4.9	4.4	4.70	94.00
4	Selection of learning resources	4.7	4.7	4.6	4.67	93.33
5	Language	4	4.5	4.5	4.33	86.67
	Average of raters	4.7	4.68	4.52	4.63	92.67

validation results listed in table 5 show that the assessment obtained for all components of the lesson plan is 4.63 with a match percentage between validators of 92.67% so that the validity of the lesson plan is categorized as feasible. The reliability test on the assessment of the lesson plan component between validators was carried out by calculating the reliability value of the ICC Two-way mixed model using SPSS 23 with an average measure of 0.883 so it can be stated that the three validators have a good agreement value on the lesson plan Based on the acquisition of these values, it can be concluded that the lesson plan is feasible to be implemented.

Research by Kurnia et al., (2021) states that project learning tools based on local wisdom are suitable for application by chemistry teachers, apart from being responsive to current issues regarding culture, they can also present the relevance of concepts to aspects of everyday life. Noorhapizah et al., (2020) stated that learning tools containing local wisdom are feasible to use and effective in developing critical, creative and logical thinking skills.

Worksheets Validity Results

The worksheets validation was carried out by three expert lecturers by providing an assessment in terms of the feasibility of the content/material, the feasibility of the presentation/display and the suitability of the language used. The results of the worksheets feasibility test can be seen in Table 6.

Table 6. Results of Ethnoscince-based PjBL Worksheets Validation by expert

No	Component	raters			Average	Rating Match
		V1	V2	V3		
1	The feasibility of the content	4.7	4.7	4.9	4.77	95.33
2	The feasibility of the contruction	4.4	4.4	5.0	4.60	92.00
3	The suitability of the language used	4.7	5.0	4.7	4.80	96.00
	Average of raters	4.60	4.70	4.87	4.72	94.44

The results of the feasibility test analysis of the student worksheets in table 6 show that the assessment obtained from the validator for all components of the student worksheet is 4.72 with a match percentage between validators of 94.44% with appropriate criteria. The reliability of the assessment of the student worksheets using the ICC obtained a value (average measures) of 0.771 so that it can be concluded that the agreement between the validators on the components of the student worksheets is categorized as good enough and can be continued for the implementation phase.

Handout Macromolecule Validity Results

The assessment of the handout includes aspects of the suitability of the language used, content or feasibility, presentation/construction feasibility and appropriateness of the language rules used. The results of the handouts feasibility test can be seen in Table 7.

Table 7. Results of Ethnoscince-based PjBL Handout Validation by expert

No	Component	Raters			Average	Rating Match
		V1	V2	V3		
1	The suitability of the language used	5.0	5.0	5.0	5.0	100.00
2	The feasibility of the content	4.6	4.7	5.0	4.76	95.33
3	The feasibility of the contruction	4.7	4.7	4.7	4.70	94.00
4	The language rules used	4.3	5.0	5.0	4.76	95.33
	Average of Raters	4.65	4.85	4.92	4.80	94.17

The results of the Handout feasibility test analysis in table 7 show that the assessment obtained from all validators for all components of the Handout is 4.80 with a match percentage between validators of 94.17% which is categorized as very feasible. The reliability of the Handout assessment was calculated using the ICC with the help of SPSS 23, which obtained an average measure of 0.957 so that it can be concluded that the agreement between the validators on the Handout component is categorized as very good and can be continued for the implementation phase.

Critical Thinking Skills Test Validation Results

Assessment of the validity and reliability of critical thinking skills test questions was carried out by 3 experts covering aspects of construction, clarity and relevance. The results of the validity and reliability of the item items were then analyzed using the V Aiken coefficient and the ICC with the help of SPSS 23 which are described in Table 8.

Table 8. Critical Thinking Skills Test Validity and Reliability Results

Items	Contruction	Category	Clarity	Category	Relevance	Category
1	1.0	High	0.9	High	1.0	High
2	0.9	High	0.7	Moderate	1.0	High
3	1.0	High	1.0	High	1.0	High
4	1.0	High	1.0	High	1.0	High
5	0.7	Moderate	1.0	High	0.7	Moderate
6	0.9	High	1.0	High	0.9	High
7	1.0	High	1.0	High	1.0	High
8	0.8	High	0.9	High	0.7	Moderate
9	1.0	High	1.0	High	1.0	High
10	0.9	Tinggi	1.0	High	1.0	High
11	0.9	High	1.0	High	0.7	Moderate
12	0.7	Moderate	1.0	High	1.0	High
13	1.0	High	0.7	Moderate	0.8	Moderate
14	1.0	Moderate	1.0	High	1.0	High
15	0.9	High	0.7	Moderate	0.8	High
Reliability value	0.801	High	0.917	High	0.883	High

The results of the V Aiken analysis show that all items are categorized as valid because they have met the V Aiken coefficient limit for 5 rating scales with 3 raters, namely 0.92 and probability 0.32 (Aiken, 1985). The coefficient V obtained for each aspect is 0.93 for the construction of the questions, 0.94 for the clarity of the questions and 0.92 for the relevance of the questions so that the questions are declared valid and feasible to use. The results of the ICC analysis show a good level of reliability for the three aspects of the assessment because they are in the range of 0.76-0.90 (Portney, et al., 2009). The questions that have gone through the validation process are then tested on 3rd semester students of Ar-Raniry State Islamic University. This is done by considering that the material used in this study is macromolecules taught in class XII chemistry subjects, so that at least sthis instrument is tested on students who have studied it or one level above.

Table 9. Empirical Validity of Critical Thinking Skills Test

Item	Validity	Difficulty Level	Differentiation power	Reliability	Criteria
1	0.895	0.578	0.417		Valid
2	0.897	0.500	0.417		Valid
3	0.740	0.556	0.375		Valid
4	0.748	0.300	0.333		Valid
5	0.850	0.589	0.333		Valid
6	0.578	0.622	0.208	0.951	Valid
7	0.760	0.556	0.375		Valid
8	0.842	0.478	0.417		Valid
9	0.458	0.622	0.542		Valid
10	0.851	0.500	0.458		Valid
11	0.606	0.667	0.208		Valid

12	0.897	0.589	0.500	Valid
13	0.890	0.544	0.333	Valid
14	0.748	0.300	0.333	Good
15	0.757	0.578	0.417	Valid

Table 9 shows that the analysis of validity, difficulty index, discriminating power and reliability for critical thinking skills tested on students shows that there are 7 items that have "very high" validity, namely items 1, 2, 5, 8, 10, 12. and 13, for "High" validity there are 6 items, namely 3,4,7,1,14, and 15 and 2 questions with "sufficient" validity, namely items 6 and 9. The difficulty index shows 2 items categorized as "difficult". on questions 4 and 14, and the remaining 13 items are categorized as "medium". Then the distinguishing power for questions 1,2,8,9,10,12 and 15 is in the good category, 3,4,5,6,7, 11, 13 and 14 in the sufficient category. The reliability of all items is obtained at 0.951, which means that the questions have very high reliability. Based on this analysis, it can be concluded that all questions can be used because they have met the quality test.

The indicators used to state the appropriate learning tools are based on the opinion of Nieveen (1999) which includes two criteria, namely (1) the validity of the content of the device developed is strong based on theoretical rationale and (2) there is internal consistency between the components of the device with one another. Based on these criteria, it can be concluded that the learning tools developed are valid because they meet the first criteria regarding the validity of the content assessed by experts (expert judgments). The average validity value and the ICC also show valid results so that the second criterion has been met. The improvement of students' critical thinking skills was reviewed by using pretest-posttest questions that were developed previously. The pretest-posttest scores were analyzed to determine whether there was an increase in students' critical thinking skills before and after the implementation of ethnoscience-based PjBL tools. The analysis was carried out using the N-Gain test with the help of microsoft excel to see the improvement and the normality test using the Shapiro-Wilk test with the help of SPSS 23 software to determine whether the data was normally distributed or not before the t-test was performed. The results of the analysis are summarized in Table 10.

Table 10. Improving Critical Thinking Skills Results

Average		Normality		N-gain	Category
Pretest	*Posttest*	*Sig.Pretest*	*Sig.Posttest*		
17.50	76.73	0.38	0.15	0.88	High

Based on the presentation of the data above, it is known that the acquisition of students' pretest scores before the implementation of learning tools is 17.50 which indicates that students' critical thinking skills are still low. After the implementation of the developed learning tools, starting with PjBL learning with an ethnoscience approach, the use of worksheets and Handouts showed an increase in students' critical thinking skills. This is reviewed based on the average posttest score of 83.33 with an N-gain value of 0.88 which is classified as high (Hake, 1998). This indicates that the critical thinking skills of students after the implementation of Ethnoscience-based PjBL learning tools have increased. Sumarni, et al (2020) said that ethno-STEM-based project learning was able to increase the average critical and creative thinking skills of students on all indicators that varied from low to moderate categories. Based on the t-test data obtained the value of sig. (2-tailed) of (0.000) < (0.05), it can be concluded that there is a significant difference between students' critical thinking skills before and after the implementation of Ethnoscience-based PjBL learning tools. This is in line with Desiana (2022) research that there is a significant difference between classes that apply the Project based learning (PjBL)

model and classes that apply the direct learning model where the PjBL model is able to improve students' critical thinking skills for the better.

Critical thinking skills can be improved by paying attention to the characteristics and potential of the learner's learning environment. Parmin, et al (2019) suggest that cultural developments in society can be included in the development of science teaching materials. This research is focused on developing learning tools in the form of lesson plans, worksheets handouts and questions about critical thinking skills using ethnoscience-based project based learning stages. The project of making macromolecule products is adapted to the context of local wisdom in Bireuen district. Students are expected to be able to analyze the structure, nomenclature, nature and use of carbohydrates in the basic ingredients of making nagasari, analyze the structure, nomenclature, reactions and uses of proteins based on the process of making shredded milkfish (*muloh*) and analyze the structure, nomenclature, reactions and functions of fats in oil. simplah (oil from *pliek ue* fermentation) which is used as a base for making solid soap. Cultural-based contextual learning profiles can increase learning effectiveness and have a significant effect on learning activity (Rahmawati, et al., 2019), the tendency to think critically will be more open to the diversity and challenges provided (Alvarez, et al., 2022). Research by Wahyudiati, et al. (2023) states that product culture and local wisdom values have relevance to chemicals so that they can be used as learning resources in various perspectives of analogy, representation and visualization of students to make it easier to understand concepts.

The novelty of worksheets PjBL based on ethnoscience is that it consists of project learning steps that allow students to find concepts from a material. PjBL's steps are combined with an ethno-science approach that raises topics uniquely local to Aceh. Each step of the activity is arranged systematically based on the PjBL syntax. Worksheets is also equipped with analytical questions that contain indicators of critical thinking skills so that it is different from worksheets in general. In addition, the worksheets is also equipped with a project report format to make it easier for students to complete the assignments given. Novitasari, et al. (2021) mention in their research that the use of worksheets can increase the effectiveness of chemistry learning and train students' critical thinking skills with an average in the medium category. the use of local wisdom contexts in worksheets can create a contextual learning process so that students will be stimulated to think critically, actively and creatively, a pleasant atmosphere and easy to understand concepts that affect learning interest and achievement (Deda, et al., 2021). Sudarmin et al (2019) stated that the lesson plan integrated with green chemistry and ethnoscience is useful for improving students' thinking skills in three thinking domains; cognitive, psychomotor and affective. In line with the research of Widyaningrum, et al. (2020) worksheets which presents local wisdom content can add meaning to learning and have implications for instilling a love for culture. Nurcahyani et al., (2021) argued that local wisdom in teaching materials greatly influences the competence of students, especially in the realm of scientific knowledge and attitudes.

The uniqueness of the macromolecular Handout that was developed raised various topics that were related to the context of local Acehnese wisdom. The presentation of information is accompanied by attractive illustrations and pictures to make it easier for students to read and remember it. The key to critical thinking skills is when students are able to remember and understand the knowledge they acquire logically based on previous knowledge (Shaughnessy, et al., 2017). Cognitive skills that are empowered through critical thinking activities can help students gain improved learning outcomes (Khasanah, et al., 2017). Exploratory activities during project learning can stimulate students to think more critically (Issa, et al., 2021). The contextual approach has a positive impact on learning (Anjarwati, et al., 2022). In general, students who learn to use project metacognitive skills learning show excellent abilities in providing further explanations about what they are learning (Ijirana et al., 2022). The PjBL model can improve students' critical

thinking skills in providing simple explanations, building basic skills and concluding (istiqomah, et al., 2022).

Assessing critical thinking skills can use open-ended assignments or essay questions that can stimulate students to process their reasoning explicitly (Larsson, 2017). Researchers developed 15 items using critical thinking indicators Ennis (2011) to review the improvement of students' critical thinking skills. Critical thinking skills are important to develop (Butler, et al., 2017). It should be noted that a number of pedagogical approaches that facilitate the development of critical thinking arise from independent learning experiences because they allow students to share and discuss their ideas, students can ask open-ended questions and organize group discussion activities (Zhong, et al 2021). PjBL is an active method that can develop maximum student involvement and participation in the learning process. The learning tools developed have emphasized collaborative activities of students to investigate, make decisions and respond to project challenges so as to increase awareness, reflexivity and critical spirit (de la Torre-Neches et al., 2020). Therefore, improving students' critical thinking skills cannot be separated from the learning methods that are being implemented. Relevant research shows that the development of local wisdom-based PjBL models can improve students' ability to solve environmental problems with an average N-gain of 0.69 which is categorized as moderate (Retnowati, et al., 2020), ethno-STEM PjBL integration can train critical thinking skills and creative learners (Ariyatun, 2021).

Response students and teacher analysis results

Empirical validity was reviewed through a questionnaire of teacher and student responses to the components of Ethnoscience-based PjBL learning tools after the implementation phase. The teacher's response questionnaire contains a number of assessments of the components of the learning tools that have been prepared, while the student response questionnaire contains a number of statements that describe students' attitudes towards the learning experience, interest, use of time and learning resources presented in Ethnoscience-based PjBL learning tools. The results of the interpretation of the student response questionnaires can be seen in Table 11.

Table 11. Students response questionnaires results

No	Component	Results	Response	Criteria
1	Learning Experience	112,5	85,23	Very Agree
2	Motivation	117,6	89,09	Very Agree
3	Times used	111,2	84,28	Very Agree
4	Learning Resources	114,6	86,82	Very Agree
	Average	113,9	86,35	Very Agree

The results of the analysis of student responses on the learning experience aspect showed a very agreeable attitude with the results of 112.5 and the percentage of 85.23. Ethnoscience-based PjBL learning provides students with experience to solve the challenges of gathering information and solving problems given in completing projects. The skills of students in project planning, communication, interpersonal relationships among team members and formulating innovations to improve product quality are also trained in this learning, so that in the end students are able to understand the basic concepts of macromolecules taught through the integration of an ethnoscience approach and gain a lot of new information. regarding the contextuality of chemical concepts with local products. Interaction during the learning process allows students to gain new experiences and skills, both in terms of theory and application because they must produce projects of real value (Spalek, 2014). Blumenfeld et al (1991) mention that comprehensive student involvement in project learning can maintain motivation and thinking skills. Shin (2018) also agrees

that students' responses to project learning show very positive perceptions on aspects of motivation and self-efficacy at various levels, grades or age groups. Learning motivation can increase when students are given the option to determine their own learning, compared to sitting and listening to the delivery of material, students will be more interested if they can be directly involved in finding the urgency of the material for them, and through PjBL they can make it happen (Heuerman, 2020). Kasi et al. (2021) mention that the ethnoscience approach is highly recommended as a method that supports conceptual understanding, problem solving skills, critical thinking skills and motivation in learning science. Project learning enables students to apply and develop future opportunities. Collaboration skills taught in PjBL are seen as life skills that students need to learn for their future (Heuerman, 2020).

The results of the questionnaire analysis of teacher responses to the components of learning devices are summarized in Table 12.

Table 12. Teacher response questionnaires results

No	Component	Results	Response	Criteria
1	Lesson plan	4,9	98,09	Very Agree
2	Worksheets	4,8	96,66	Very Agree
3	Handout	4,6	83,33	Very Agree
4	Critical thinking skills test	5,0	100	Very Agree
	Average	4,82	96,71	Very Agree

The results of the analysis of the assessment of the learning device components by the teacher showed a very agreeable attitude that the learning components were stated to be very good in terms of content/content, construction/presentation and language with the average acquisition of all components of 4.82 with a percentage of 96.71. An indicator that states that the developed tool is feasible if the practitioner or user states in theory that the tool can be implemented in the field with a good level of implementation. As the opinion of Nieveen (1999) which states that the practical criteria are based on two assumptions, namely (1) practitioners state that the developed tools can be applied; (2) the developed tools can be implemented and can be implemented in real terms in the field. Based on the explanation above, it can be concluded that ethnoscience-based PjBL learning tools are declared feasible based on empirical validity because they get a very good response from teachers and students. Students need sufficient knowledge, effort, perseverance and self-regulation when working on projects because they need to plan, gather information and evaluate findings (Tiwari, et al., 2017). Teachers as facilitators need to allocate sufficient learning time so that students can play their roles, and provide opportunities to discover, develop thinking skills and build new understandings.

Conclusion

Based on the results of the study, it can be concluded that the ethnoscience-based PjBL learning devices is declared very feasible to be implemented because it has met the feasibility of content validity and empirical validity. The results also show that the implementation of ethnoscience-based PjBL tools on macromolecular materials can improve the critical thinking skills of students with high categories which are reviewed through the acquisition of an N-gain value of 0.88, and received a positive response from the teacher with a percentage of 96.71% and students by 86.35%.

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