



Improving environmental literacy through the development of problem-based learning models that incorporate local wisdom

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Abstract

This study aimed to determine the validity of the problem-based learning with local wisdom in Acehnese oriented to socio-scientific issues to improve students' environmental literacy, and to find out the practicality of the problem-based learning with local wisdom oriented to socio-scientific issues model, to improve students' environmental literacy. This research used the design of developmental research stages according to Branch that consists of Define, Design, Develop, Disseminate (4D). Data collection was conducted by using instruments in the form of tests, questionnaire sheets, and product validation sheets. The data was analyzed by adopting qualitative data with content analysis techniques and quantitative data were analyzed with descriptive statistics. The results showed that problem-based learning with local wisdom oriented to a socio-scientific issues model was proven to have a level of validity and practicality to improve students' environmental literacy. This study concludes that the design of problem-based learning with local wisdom oriented to socio-scientific issues models and its supporting tools are feasible to use to improve students' environmental literacy skills with good categories.

Keywords: Environmental literacy; local wisdom; problem-based learning; socio-scientific issue

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1. INTRODUCTION

The education decentralization policy's execution has far-reaching ramifications for efforts to improve educational quality. It is feared that it may lead to a lack of clarity in quality standards, as well as the rise of disparities in educational quality between areas and schools. Decentralization of education necessitates a significant financial commitment from each region and educational institution. Participation of the community in education regionalization strategies is a necessary and even a major requirement for the success of improving and strengthening education in the regions.

In 21st-century education and the 4.0 industrial revolution, students must be able to understand the very fast changes and require critical and creative thinking and other thinking skills to be able to deal with them well (Awodiji & Naicker 2024). Teachers and students must be able to apply 21st-century skills in learning by prioritizing thinking skills and utilizing integrated technology (Akmal, 2019; Ahmad et al., 2016; Sihombing et al., 2018; Shakirova et al., 2024; Mhlanga, 2024). Since students have different ways of understanding concepts, teachers must be creative and innovative in their development of learning models by giving students access to explore concepts at a higher level of complexity (Arisjanti et al., 2014; Hapsari et al., 2019; Nachreiner et al., 2015).

Scientific literacy is one of the key outcomes of science education. According to Eymur and Çetin (2024), scientific literacy is the capacity to learn new things, recognize problems, and apply technology that calls for scientific analysis, explanation, and evidence-based data interpretation. Scientific literacy helps individuals form patterns of thinking, and behavior, and build human character to care and be responsible for themselves, society, and the environment as well as the problems they face (Noor, 2020; Winarni et al., 2024). Environmental literacy is a skill that provides basic knowledge, skills, and motivation to maintain, restore, or increase contributions to the environment (Erdogan et al., 2009). However, parents are large contributors to environmental literacy in children (Liu et al., 2022). Many schools have not implemented environmental education yet, so students do not proceed with environmental literacy (Singelton, 2017).

Scientific literacy is still developing and includes environmental issues so environmental literacy intersects with scientific literacy (Kaya & Elster, 2018). This requires environmental literacy to be implemented in schools. In order to foster an appreciation for the environment and preserve the availability of natural resources, educators should focus on helping students solve environmental damage issues in their communities (Sukarno & Maulida, 2014; Tivani & Paidi, 2016). However, according to studies by Prasetyo (2017) and Farwati et al. (2017), pupils' environmental literacy is still lacking because environmental literacy programs are not being built.

Numerous challenges exist, such as the constraints of educational instruments, the discrepancies between curriculum content and learning materials, a lack of adequate learning resources, and pertinent educational media (Veisi et al., 2019; Fidan & Ay 2016). A learning strategy that may maximize environmental literacy is necessary for the classroom learning process. The Problem-Based Learning paradigm is deemed suitable for implementation as it incorporates current local knowledge (Christiansen et al., 2013; Gewurtz et al., 2016; Abbey et al., 2017). Local cultural knowledge may be promoted by using local wisdom as a learning resource (Hadi, 2018; Hadi & Dazrullisa, 2018; Caniglia et al., 2023). Students can most easily understand the learning content and meet the learning competencies when the learning method is based on local culture and wisdom.

In practice, PBL that incorporates local wisdom still needs additional elements to address the current

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drawbacks, including the application of socio-scientific issues. Socio-scientific issues (SSI) provide contextual learning situations required by PBL. According to Zeidler et al. (2009) and Subiantoro & Ariyanti (2013), SSI offers chances for the development of scientific skills, moral issue investigation, moral reasoning, and reflective judgment abilities. As a result, the students can make scientific conclusions about issues that have social worth and arise in their social surroundings.

1.1. Purpose of study

Based on earlier research, this study aims to address the limitations of that earlier research by creating a PBL model that incorporates local knowledge known as Laot customary law (PBL-HL) oriented Socio-Scientific Issue to enhance students' environmental literacy in Aceh. Deal on the results of several previous studies, it can be concluded that the importance of developing a PBL model combined with Laot customary law (PBL-HL) oriented to Socio-Scientific Issues to improve environmental literacy. Thus, the question of this research is "how is the validity and practicality of the PBL model combined with Laot customary law (PBL-HL) oriented to Socio-Scientific Issues able to improve environmental literacy."

2. METHOD AND MATERIALS

2.1. Research model

This study adopts a developmental research design with the four stages involved; analysis, design, development, and evaluation. The components developed are in the form of a learning model in which there are syntax and learning tools (syllabus, lesson plans, as well as a manual for using the model).

First stage: define, the activities carried out including analyzing the competencies required of students, observing directly in the field what students need during the learning process, observing science teachers about the learning process that has been carried out, analyzing findings, and making conclusions about problems that are being faced by students and teachers during the learning process, and conducting a literature study.

Second stage: design, the tasks completed involve creating product designs by identifying model components and outlining the application of the PBL-HL model focused on social science issues. Creating a PBL model with Laot customary law (PBL-HL) focused on socio-scientific issues, which involves creating lesson plans, student worksheets, and manual book models. The learning materials selection and design of the guidance of the manual book for applying the model, instead of designing product evaluation tools that will be used to evaluate the problem-based learning with laot customary law oriented to socio-scientific issues models are prepared in this stage.

Third stage: In the process of developing the material, tasks including looking for and gathering references, creating charts, supporting tables, illustrative images, typing, arranging layouts, assembling assessment tools, and more are completed. Lesson plans, LKPD, learning model syntax, and other tools that follow the created product problem-based learning with Laot customary law directed toward socioscientific issue models in ecosystem learning are being prepared as the first product. Conducting small group trials to determine the feasibility of the product to be used in the learning process, trials are carried out to determine the level of content validity and indicators as well as analysis of research instruments. Products that have been developed are then assessed by experts to check the feasibility of the product and conducting small group trials to determine the feasibility of the product to be used in the learning process after the feasibility test is carried out, the findings that have been obtained will then be revised again.

Fourth stage: disseminate, and evaluate the results of products that have been developed.

The expert test was carried out on 2 learning model experts and 2 material experts, this was done to produce an accurate initial product that could be used on students, while the material was carried out to anticipate errors and lack of material to be taught.

2.2 Participants

The participants of the research were students for class X SMA in Aceh which partially were selected purposively. This research has been carried out for three months, starting from October to December 2020. The context of this research is to develop and validate a PBL model combined with laôt customary law (PBL-HL) oriented to socio-scientific issues to improve environmental literacy for class X SMA in Aceh.

2.3 Data collection tools

Data collection in this study consisted of quantitative tools. Qualitative data were obtained from the responses of material experts and media experts regarding the material, learning, and display aspects. This study used several instruments in data collection, including environmental literacy test instrument questionnaires, in addition to the model practicality assessment sheet from learning model experts, and material assessment sheets from material experts. This product practicality assessment sheet aimed to obtain data related to the practicality of problem-based learning with laôt customary law oriented to socio-scientific issues models along with supporting tools.

2.4. Data analysis

The analytical method used for this study was qualitative descriptive analysis. The approach of qualitative descriptive analysis was applied based on the outcomes of the material and media experts' validation. This instrument is being validated to ensure both content validity and empirical validity. The instrument validation in this study was with the Aikens' V formula, which is to determine the content validity coefficient, which is presented in Table 1 below.

Table 1

Criteria for instrument validity level

V-Value	Validity Level
.80 – 1.00	Very high
.60 – .80	High
.40 – .60	Currently
.20 – .40	Low
.00 – .20	Very Low

The Cronbach alpha index is used to compute the instrument's estimated dependability. Table 2 presents the categorization of instrument dependability levels.

Table 2

The level of reliability based on the value of alpha

Alpha	Reliability level
.00 - .20	Less Reliable
> .20 – .40	Somewhat Reliable
> .40 – .80	Quite Reliable

> .60 – .80
> .80 – 1.00

Reliable
Very Reliable

The data that has been analyzed from the results of the practicality assessment sheet for the problem-based learning with laôt customary law (PBL-HL) oriented to socio-scientific issues models, then all collected data is calculated using the following equation.

$$x = \frac{\sum x}{n}$$

Information

x = average score

$\sum x$ = total score of each assessor for a certain component

n = number of raters

The score that has been obtained in the form of a quantitative score is then converted into qualitative data (interval) with a scale of five. This data conversion category is adjusted to the level of tendency (Mardapi, 2008) which can be shown in Table 3 below.

Table 3
Category for determining product criteria interval

Score interval	Value	Category
$x > (\bar{X}_i + 1,8sb_i)$	A	Very worthy
$(\bar{X}_i + 0,6sb_i) < X \leq (\bar{X}_i + 1,8sb_i)$	B	Worthy
$(\bar{X}_i - 0,6sb_i) < X \leq (\bar{X}_i + 0,6sb_i)$	C	Decent enough
$(\bar{X}_i - 1,8sb_i) < X \leq (\bar{X}_i - 0,6sb_i)$	D	Not feasible
$X \leq (\bar{X}_i - 1,8sb_i)$	E	Very inappropriate

Information:

X = Average final score

\bar{X}_i = Ideal mean (1/2 (maximum score + minimum score))

sb_i = ideal standard deviation (1/6 (maximum score – maximum score))

The feasibility of the model can be tested as well as testing the validity of the instrument, namely the expert or practitioner test. The data that has been obtained is then analyzed by determining the level of trend (Mardapi, 2008).

3. RESULTS

3.1 The findings demonstrating the validity of the paradigm of problem-based learning with Laôt customary law directed at socioscientific concerns

The government policy of both central and local governments embodied in the administration and

politics in the form of government regulations is the rule of law made by the Government. It contains the government’s decision to carry out all wills in various dimensions included in a policy called regulation. At the regional head level, the policy is realized in the administrative and political policies forming the decision of the regional head. Local Head policy is a rule of law formed by the regional head and its contents include his decisions or the decision of the Regent/mayor in organizing the government according to his functions and duties in various dimensions of Life. Meanwhile, the field of education policy is set in the strategic plan of the Regional Device work unit of Sleman Regency in 2016-2021. The Education Office's strategy and policy consist of (1) increased access, quantity, and quality of curriculum infrastructures (2) improvement in students' quality (3) improvement of quality, competence, and professionalism of educators and education personnel, and (4) Innovation services Public. The policy is common and applied to all educational institutions under the authority of the education service. As for the educational standing of madrasas at the Education office, madrasas are positioned equal to private schools whose management is under their managing foundation, while the education of madrasas is under the auspices of the MRA office.

Four experts evaluated ten parts of the Mardani book on problem-based learning with Laôt customary law geared to socio-scientific issues models to validate the model of problem-based learning with Laôt customary law. The aspects included the following: (a) cover; (b) introduction; (c) basic concepts; (d) syntax; (e) social system; (f) the principle of reaction; (g) support systems; (h) instructional impact and accompaniment; (i) cover; and (j) language. The assessment of the sub-aspect items in the model book was done by giving a checklist of the columns that have been given a score from 1 to 4. Description of the score criteria 1 means that it is not good; a score of 2 means less than; a score of 3 means good; a score of 4 means very good. On the validation sheet, there is also a suggestion column that can be filled in by the validator or expert. Model validation was carried out in several revision processes by following input and suggestions from four experts. The findings from the validator's evaluation of the problem-based learning course on Laôt customary law with a focus on socio-scientific issues are presented in the models in Table 4.

Table 4
Final assessment of the model content experts

Aspect	Average index V	Category
Cover	.917	Very high
Introduction	.917	Very high
Basic Concepts	.917	Very high
Syntax	.917	Very high
Social system	.833	Very high
Reaction principle	.917	Very high
Support system	.833	Very high
Instructional impact and accompaniment	.9.17	Very high
Closing	.833	Very high
Language	.917	Very high
Average	.89	Very high

Concluding Table 4, it can be said that Aiken's examination of the model content validators' assessment

results yielded the value of V. With an overall average value of 0.89 items in the very high category, the assessment results show that the model expert validator offers an evaluation of the problem-based learning with Laôt customary law oriented to socio-scientific concerns model book. Once the final evaluation has been altered based on expert comments and input, the model can be used with reasonable success. Following the model's validation, the content expert model makes the following recommendations: (a) The major principles of Socio-scientific issues need to be emphasized; (b) Student learning activities using social issues need to be clarified; (c) Need to review the epistemological/theoretical model development; (d) Need to re-explain the indicators of the dependent variables.

3.2. Validation of the information contained in the recommendations for applying the socio-scientific issues model to problem-based learning with Laôt customary law

Four experts validated the principles for integrating Laôt customary law with problem-based learning, with an emphasis on the socio-scientific problems paradigm. The assessment is carried out by assessing four aspects, namely cover, layout, the content of the guidelines for using the model, and language. The score given by each indicator on the validation sheet is in a range of 1-4, 4 means the category is very good; 3 means good category; 2 means the category is not good and 1 means the category is not good. The validation of the guidelines for using the model was carried out in several revision processes according to the input and suggestions of four experts. The results of the final assessment of the content experts of the guidelines for using the model are presented in Table 5.

Table 5
Validation results of model usage guidelines

Aspect	Average index V	Category
Cover	.83	Very High
Layout	1.92	Very High
Fill in the model usage guide	.83	Very High
Language	.83	Very High
Average	.85	Very High

Table 5 leads one to the conclusion that Aiken's study of the expert or validator's evaluation of the substance of the model's usage instructions produced the value of V. The assessment's findings demonstrate that the expert/validator of the model's usage guidelines offers an evaluation with an overall average value of 0.85 for the very high category item. The assessment is the outcome of the final evaluation that has been updated to make the model's usage instructions viable based on expert advice and input. Several recommendations are made based on the findings of the validation of the model's usage guidelines, including the following: (a) Cover needs to be adjusted to the contents of the book; (b) Need to add an introduction and purpose; (c) Need to add teacher and student activities explicitly.

3.3. Validation of learning tools

3.3.1. Validation of learning implementation plan

It took four experts to validate the learning implementation plan. The assessment was carried out by assessing six aspects, which are the identity of the lesson plan, learning objectives, learning resources,

learning activities, assessment, and language. The score given by each indicator on the validation sheet is in the range of 1-5 where a score of 5 means the category is very good; a score of 4 means good category; a score of 3 means enough category; a score of 2 means the category is not good and a score of 1 means the category is not good. The validation of the learning implementation plan was carried out in several revision processes according to the input and suggestions of four experts. The results of the final assessment of the content experts of the lesson plan are presented in Table 6.

Table 6
Outcomes of examining learning implementation strategies

Aspect	Average index V	Category
RPP Identity	.625	High
Learning objectives	.688	High
Learning resources	.750	High
Learning activities	.813	Very high
Evaluation	.813	Very high
Language	.688	High
Average	.729	High

Table 6 suggests that the value of V indicates the findings of Aiken's study of the expert or validators' evaluation of the learning implementation plan's content. The results of the assessment indicated that the expert or validator of the learning implementation plan provides an assessment with an overall average value of 0.729 items in the high category. The assessment is the result of the final assessment after being revised by following suggestions and input from experts so that the learning implementation plan is feasible to use. The results of the validation of the learning implementation plan provide several suggestions as follows: (a) It is necessary to reduce achievement indicators in activities; (b) Time allocation needs to be readjusted; (c) Learning resources and learning tools need to be adjusted to the learning objectives.

3.3.2. Validation of Student Worksheets

The validation of the student worksheets was carried out by 4 experts. The assessment is carried out by assessing five aspects, namely cover, illustration, format, LKPD content, and language. The score given by each indicator on the validation sheet is in the range 1-5 where a score of 5 means the category is very good; 4 means good category; 3 means enough category; 2 means the category is not good and 1 means the category is not good. Validation of student worksheets is carried out in several revision processes according to input and suggestions from four experts. The results of the final assessment of the student worksheet experts are presented in Table 7.

Table 7
Findings from validation of student worksheets

Aspect	Average index V	Category
Cover	.81	Very high

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Illustration	.75	High
Format	.81	Very high
Fill in LKPD	.75	High
Language	.88	Very high
Average	.80	Very high

Table 7 indicates the value of V derived from Aiken's study of the experts' or validators' evaluation of the student worksheets' contents. The evaluation findings indicated that the item in the very high category had an overall average value of 0.80 for the expert or validator of the student worksheets. The assessment is the end product of the final evaluation that has been modified in accordance with expert advice and input to make the student worksheet workable. The student worksheets' validation results offer many recommendations, such as the ones listed below: (a) It is necessary to emphasize more the customary law of Laot; (b) Operational instructions for using LKPD need to be clarified.

3.3.3. Validation of environmental literacy instruments

Question validation was also carried out by four validators who were then analyzed using Aiken's V. The reliability of the knowledge questions of four validators was then analyzed using Aiken's V. Based on the validation results from the validators, it was stated that the environmental literacy question was declared valid with a value of V = 0.80.

3.4. The results of the practicality of the Socio-Scientific Issue-oriented PBL-HL model

The results of the limited test of the practicality of the problem-based learning with laot customary law oriented to the socio-scientific issues model were obtained from observations made by two observers during five meetings in the learning process. The findings from the use of problem-based learning with Laot customary law, which is based on the socio-scientific problems model, in the educational process, are displayed in Table 8.

Table 8

Practical observation results

Aspect	Value	Category
Syntax	84.17	High
Reaction	8.5	High
principle		
Social principle	88.33	High
Support system	87.5	High
Average	86.13	High

Based on Table 8, using the problem-based learning with Laot customary law oriented to socio-scientific issues model obtained an average of 86.13, which is in the high category. This category is based on the practicality category of Koyan (2012).

4. DISCUSSION

From the results of observations in this limited trial, there are still shortcomings that need to be improved, namely; (1) on the application of syntax: the teacher has not been able to carry out apperception activities effectively, where the teacher has not perfectly directed and explained the images and videos

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displayed; (2) on the principle of reaction: teachers are less able to provide motivation and assistance when preparing learning resources and during investigations; (3) on social principles: teachers have not given the freedom to students in expressing opinions and teachers are also not maximal in interacting with students; (4) on the support system: teachers have not been eager in carrying out learning in line with the RPP and using LKPD. The results of small-scale trials of the practicality of using this model become a reference for large-scale trials. The findings of the observations indicate that, although there are still certain areas that might be improved, using problem-based learning with Laôt customary law oriented to the socio-scientific concerns model is in the practical category. This indicates that, in comparison to the small trial, the large-scale trial's application of problem-based learning with Laôt customary law oriented to the socio-scientific concerns model was of higher quality.

The study's ultimate output is a manual for utilizing the socio-scientific problems model, which includes pre-existing learning resources including lesson plans, syllabi, worksheets, and evaluation tools, along with problem-based learning with Laôt customary law. The final product development has been verified and updated in accordance with practitioner and expert recommendations. It can therefore be used to enhance the educational process in schools. Based on the overall mean value of the content validation coefficient (V), which is all larger than .80, the problem-based learning with Laôt customary law oriented to socio-scientific issues model has a very good degree of validation. We can therefore infer that the model is appropriate for use in supporting junior high school instruction. As per the assessment results, the model expert validator rates the problem-based learning model book with Laôt customary law geared towards socio-scientific issues at a total average of .89 items, placing it in the very high category. After being changed based on expert comments and input, the assessment is the outcome of the final assessment, in order to make the model workable.

Outcomes of Aiken's examination of the evaluation of the substance of the model's usage instructions by the expert or validator. A total average value of .85 items in the very high category indicate the outcome of the evaluation of the model's usage recommendations. The assessment is the outcome of the final evaluation that has been modified in accordance with expert advice and input to ensure that the model's usage recommendations are workable.

The findings of Aiken's examination of the evaluations conducted by specialists or evaluators of the information contained in the learning implementation plan. The assessment results indicated that the learning implementation plan expert or validator scored an overall average of .729 for items in the high category, while the expert or validator who assessed the student worksheet content scored an overall average of .80 for items in the very high category. The assessment is the outcome of the final evaluation that has been modified in accordance with expert advice and input to make learning implementation plans and student worksheets workable. The average score for the practicality test of the problem-based learning model with Laôt customary law geared to socio-scientific issues was 86.13 in the high category, based on observations made by two observers during the learning process. This category is based on the practicality category of Koyan (2012).

The researcher developed a model for problem-based learning with Laôt customary law oriented to socio-scientific issues. Since it is intended for in-person instruction and direct student interaction, it can be adjusted and utilized as an online learning tool to enhance environmental literacy. Environmental literacy is an individual's understanding of environmental awareness in interacting with nature (Agfar et al., 2018; Safitri et al., 2020). Environmental literacy is significant in building individuals' sensitivity to the value of

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caring for the environment, this can be started from learning that aims to make each student literate/aware of the environment from an early age. Many learning models have been used in the learning process in schools that are adapted to the characteristics of students, materials, and existing facilities. The teacher has implemented a learning model that requires students to be able to build their knowledge and develop their abilities independently to find the truth of the problems around them so that they can increase their intellectual abilities. But sometimes students are not aware of it.

By integrating traditional legislation from the Laôt region with models of socio-scientific challenges, problem-based learning allows educators to leverage media and technology to support students' learning. Media and technology combined can be a teaching tool that assists students in resolving conflicts in real-world situations (Klostreman et al., 2012; Presley et al., 2013). Furthermore, in socioscientific situations, SSI can engage students in dialogue and help them make decisions based on scientific evidence (Sadler & Dawson, 2012; Zeidler et al., 2013).

The research findings indicate that it is possible to construct and apply problem-based learning with Laôt customary law that is directed toward the socio-scientific concerns model. Furthermore, the topic under study as a socio-scientific issue has relevance to the idea of science as the root of the issue, conflicts surrounding science, and socio-moral viewpoints. It also creates room for different viewpoints when making decisions based on one's scientific knowledge (biology). This may entail approaching a topic from a humanistic social perspective.

Numerous research findings that incorporate local culture into education to create a learning model that can benefit students, instructors, and the community support this. Students will, in general, acquire knowledge of the subject topic and the local cultural values found in the vicinity of their location, increase understanding of concepts (Mukin et al., 2020), interest and motivation to learn students (Munawaroh et al., 2017); learning outcomes (Ramdiah et al., 2020); improve literacy (Ilhami et al., 2019) and conservation character (Khusniati, 2017), foster character values to develop students' life skills (Hasanah et al., 2016).

According to research by Sela et al. (2018), applying problem-based learning models based on local wisdom might enhance students' critical thinking abilities when they are learning science. The community has a better grasp of the integration of culture and education when Indigenous peoples' local wisdom is incorporated into forest conservation efforts (Sukmawativ & Susilo, 2015).

4. CONCLUSION

According to the study's findings, the PBL-H model that was created was deemed valid by practitioners and validators, receiving a very good category rating. Validators and practitioners with strong categories have also conducted empirical tests and deemed them feasible. Students' environmental literacy can be raised with the help of the created PBL-HL paradigm. It is anticipated that as kids' knowledge grows, literacy will flourish and they will develop an environmentalist mindset. Some recommendations that could be made in light of the research findings are an impediment, the COVID-19 pandemic, was discovered at the time of the study, which resulted in time constraints on the learning process. As a result, an LMS-based PBL-HL model had to be prepared. PBL-HL based on an LMS allows students to access learning from any location.

To apply the model optimally and obtain optimal learning outcomes, teachers must comprehend and make use of the supporting materials for problem-based learning using Laôt customary law oriented to the socio-scientific concerns model. In order for problem-based learning with *laissez-faire* customary law oriented to the socio-scientific problems model to be implemented successfully, teachers must be able to

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manage their time well. Support is required during the investigative stage of the learning process. The study's recommendations, which are based on the Laot customary law-oriented to socio-scientific issues model, offer empirical data for future researchers who should be able to watch the online learning process through the use of LMSs. Additionally, these recommendations can be used to gauge students' proficiency in problem-solving and confidence in their ability to innovate using problem-based learning.

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Ethical Approval: The study adheres to the ethical guidelines for conducting research.

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