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VALIDITY OF THE ETHNO-STEM PjBL MODEL FOR OPTICS LEARNING BASED ON THE LOCAL CONTEXT OF EAST OKU

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Abstract: This study aims to develop and examine the validity of an Ethno-STEM learning model integrated with Project-Based Learning (PjBL) for optics instruction, incorporating the local wisdom context of East Ogan Komering Ulu (OKU Timur), namely the Komering River, the Perjaya Dam, and the paddy-field irrigation system. This research applies a Research and Development (R&D) approach using the ADDIE model, reported here up to the expert validation stage. The developed products, a project-based learning module and student worksheets (LKPD), were validated by six validators (two content experts, two media experts, and two instructional experts) using a 1-4 scale validation sheet. Results show content feasibility of 89%, instructional suitability of 90%, language clarity of 88%, and display quality of 85%, with an overall average of 88%, categorized as highly valid. These findings indicate that the Ethno-STEM PjBL model is feasible as a contextual alternative for optics learning. Further research is needed to examine its practicality and its effectiveness on students' creative thinking through a quasi-experimental design. The validation instrument was developed based on a teaching-material feasibility grid encompassing four aspects, namely content feasibility, instructional suitability, language clarity, and display quality, each elaborated into specific indicators and items.

Keywords: Ethno-STEM; Project-Based Learning; Model Validity; Optics Learning; Local Context

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INTRODUCTION

Physics instruction, particularly in the topic of optics, continues to face challenges in bridging abstract concepts with real phenomena in students' surrounding environment (Hanif et al., 2019; Wandari et al., 2018). Students often struggle to understand the concepts of refraction, reflection, and image formation because instruction tends to be theoretical, lecturer-centered, and weakly connected to everyday-life contexts (Huda, et al., 2020a; Huda et al., 2026; Hardini et al., 2026). This condition contributes to students' low creative thinking ability in solving problems based on real phenomena (Rohman et al., 2024; Sumarni, 2022).

From an Islamic perspective, the encouragement to observe and reflect on the natural world provides a complementary rationale for contextual science learning. The Qur'an invites people to contemplate the creation of the heavens and the earth and to reflect on the signs within it (Qur'an, 3:190–191).

QS. Ali 'Imran [3]: 190

> إِنَّ فِي خَلْقِ السَّمَاوَاتِ وَالْأَرْضِ وَاخْتِلَافِ اللَّيْلِ وَالنَّهَارِ لَآيَاتٍ لِأُولِي الْأَلْبَابِ

Artinya:
"Sesungguhnya dalam penciptaan langit dan bumi, dan pergantian malam dan siang terdapat tanda-tanda (kebesaran Allah) bagi orang-orang yang berakal."

In the context of optics education, this principle can be understood as encouraging learners to move beyond memorizing abstract laws toward observing, questioning, and interpreting natural phenomena such as reflection and refraction in their surrounding environment as part of a meaningful process of scientific inquiry (Nurulsari et al., 2020; Usman et al., 2025; Huda, et al., 2020b).

On the other hand, physics instruction in many higher education institutions has not optimally integrated local wisdom as a learning resource, even though the surrounding environment holds numerous optical phenomena that can serve as an authentic learning context (Yuliana et al., 2023a). Based on preliminary observations and interviews conducted by the researchers with the lecturer teaching the Optics course at Universitas Nurul Huda, students' difficulty in relating optics concepts to real phenomena was also consistently observed, particularly regarding light refraction and reflection. In East Ogan Komering Ulu (OKU Timur) Regency, for instance, the interaction of light with the flow of the Komering River, reflection on the surface of the Perjaya Dam, and refraction within the local paddy-field irrigation system are authentic optical phenomena that have rarely been utilized in instruction. Specifically, the turbid, sediment-laden flow of the Komering River provides a natural context for explaining

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light attenuation and the change in effective refractive index caused by suspended particles; the broad, calm surface of the Perjaya Dam illustrates planar (specular) reflection governed by the law of reflection, in which the angle of incidence equals the angle of reflection; and the shallow, moving water of the local irrigation channels demonstrates refraction at the air-water interface consistent with Snell's law (Doğru & Kurnaz, 2023; Malcolm, 2023). Integrating such local contexts has been shown to improve the feasibility and acceptance of physics learning media and models across various other topics in the South Sumatra region (Pilobu et al., 2025; Sari et al., 2025).

This orientation is also consistent with the Qur'anic invitation to repeatedly examine what is seen: "look again" at the creation (Qur'an, 67:3–4).

QS. Al-Mulk [67]: 3

> الَّذِي خَلَقَ سَبْعَ سَمَاوَاتٍ طِبَاقًا ۖ مَا تَرَىٰ فِي خَلْقِ الرَّحْمَٰنِ مِنْ تَفَاوُتٍ ۖ فَارْجِعِ الْبَصَرَ هَلْ تَرَىٰ مِنْ فُطُورٍ

Artinya:
"Yang menciptakan tujuh langit berlapis-lapis. Tidak akan kamu lihat sesuatu yang tidak seimbang pada ciptaan Tuhan Yang Maha Pengasih. Maka lihatlah sekali lagi, adakah kamu melihat sesuatu yang cacat?"

Such a perspective strengthens the pedagogical rationale for using familiar optical phenomena in the Komering River, Perjaya Dam, and irrigation channels as objects of observation and investigation. Thus, integrating local phenomena into Ethno-STEM-PjBL is not only intended to contextualize physics concepts, but also to cultivate careful observation, reflection, and intellectual curiosity while maintaining a distinction between religious guidance and empirical scientific explanation (Munifah et al., 2019; Lestari et al., 2021; Saregar et al., 2025).

The Ethno-STEM approach offers a solution by integrating indigenous knowledge into the framework of Science, Technology, Engineering, and Mathematics, thereby making science learning more meaningful and contextual (Ariyatun, 2021; Sartika et al., 2022). Meanwhile, Project-Based Learning (PjBL) provides students with the opportunity to actively engage in authentic projects that require exploration, collaboration, and creative problem-solving (Verawati & Wahyudi, 2024; Zhang & Ma, 2023), and has also proven effective in enhancing other higher-order thinking skills such as computational thinking (Zhang & Ma, 2023). Various studies indicate that integrating Ethno-STEM with PjBL consistently improves learners' critical and creative thinking skills across educational levels and science subjects (Rohman et al., 2024; Sumarni, 2022); however, its specific application to optics instruction at the higher education level, integrated with the local context of OKU Timur, remains very limited.

Previous studies have largely focused on applying STEM or PjBL to improve general mastery of optics concepts (Hanif et al., 2019; Wandari et al., 2018), or on integrating Ethno-STEM into other science subjects such as chemistry and biology (Ariyatun, 2021; Verawati & Wahyudi, 2024). Studies that specifically develop a project-based Ethno-STEM learning model for optics by drawing on the local wisdom of OKU Timur, while also examining its validity through expert judgment, have rarely been reported. In particular, the refraction of light as it passes through the sediment-laden water of the Komering River and its reflection on the still surface of the Perjaya Dam remain conceptually under-examined as instructional contexts for optics, despite their potential to concretely illustrate these principles. The novelty of this study lies in integrating Ethno-STEM into optics instruction at the higher education level, developing a project-based model grounded in an authentic local context, and orienting the model toward enhancing students' creative thinking ability.

Based on the above description, this study aims to: (1) develop an Ethno-STEM learning model based on Project-Based Learning for optics instruction within the local context of OKU Timur; and (2) examine the validity of the model based on the judgment of content experts, media experts, and instructional experts. The results of this stage serve as the basis for conducting a limited trial and an effectiveness test in the subsequent stage of the research.

METHOD

This study employed a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) (Bamrara, 2018). This article reports the results of the Analysis, Design, and Development stages, particularly the expert validation results for the developed product, while the Implementation and Evaluation stages (the limited trial and effectiveness test) are planned for the subsequent stage of the research.

At the analysis stage, the curriculum and learning outcomes of the Optics course were reviewed, students' characteristics and learning difficulties were identified, and the potential of local wisdom in OKU Timur relevant to optics concepts was mapped, including the interaction of light with the flow of the Komering River, reflection on the surface of the Perjaya Dam, and refraction within the local paddy-field irrigation system. These analysis results formed the basis for designing the learning model, namely an Ethno-STEM syntax integrated with Project-Based Learning consisting of the stages of local-phenomenon orientation, problem identification, project design, project implementation, presentation of results, and reflection-evaluation.

At the development stage, learning materials were compiled, consisting of an Ethno-STEM-based optics learning module and project-based student worksheets (LKPD) integrating local phenomena from OKU Timur, complemented by a creative-thinking test instrument and a student activity observation sheet for use in the subsequent stage of the research. Within the LKPD, the four STEM components were explicitly operationalized into concrete project tasks: the Science component required students to identify and explain the refraction and reflection principles underlying each local phenomenon; the Technology component was operationalized through smartphone light-meter applications and digital cameras used to record and quantify light behavior at the Komering River, the Perjaya Dam, and the irrigation channels; the Engineering component was embodied in tasks requiring students to design and construct a simple optical instrument (e.g., a periscope or a turbidity comparator) from locally available materials; and the Mathematics component was applied through calculating the angle of incidence and reflection, estimating the relative refractive index, and quantitatively analyzing the light-intensity data collected during the project (Muliyati et al., 2023; Rofik et al., 2025)

The developed product was validated by six validators, consisting of two content experts (in physics/optics), two learning-media experts, and two instructional/pedagogy experts. Validators were selected based on a minimum master's degree qualification in a relevant field and a minimum of five years of professional experience in their respective fields. Validation was conducted using a 1-4 scale validation sheet (1 = very poor, 4 = very good) developed by the researchers based on a teaching-material feasibility grid, assessing four aspects: content feasibility, instructional suitability, language clarity, and display quality. To further detail the validation instrument, Table 1 presents the number of indicators and items developed for each assessed aspect, together with the four-point rating scale applied by the six validators.

Table 1. Blueprint of the Expert Validation Instrument

Assessed Aspect	Number of Indicators	Number of Items	Rating Scale
Content feasibility	4	8	1-4
Instructional suitability	3	6	1-4
Language clarity	3	6	1-4
Display quality	3	6	1-4
Total	**13**	26	**-**

Expert validation data were analyzed using a quantitative descriptive technique by calculating the feasibility percentage for each aspect using the formula: $P = (\Sigma x / \Sigma xi) \times 100\%$, where P is the feasibility percentage, Σx is the total score obtained, and Σxi is the maximum possible score. The resulting percentages were then interpreted according to validity categories:

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81-100% (highly valid), 61-80% (valid), 41-60% (moderately valid), 21-40% (less valid), and ≤20% (invalid).

As a plan for the subsequent research stage, the product that has been declared valid will be tested on a limited scale with 5 students to examine the model's practicality, followed by an effectiveness test using a pretest-posttest control group quasi-experimental design involving 20 students to measure improvement in creative thinking ability through t-tests, N-gain, and Cohen's d effect size (Kraft, 2020).

FINDING AND DISCUSSION

The needs analysis results indicated that students experienced difficulty in gaining an in-depth understanding of optics concepts and relating them to real phenomena, and that instruction thus far had not utilized the potential of OKU Timur's local wisdom as a learning resource. Based on these findings, an Ethno-STEM learning model based on Project-Based Learning was developed with the following syntax: (1) local-phenomenon orientation (Komering River, Perjaya Dam, irrigation system); (2) identification of contextual optical problems; (3) project design; (4) project implementation; (5) presentation of results; and (6) reflection-evaluation.

The resulting product consists of an Ethno-STEM-based optics learning module and project-based student worksheets containing activities that explore light refraction and reflection phenomena in local objects, such as the interaction of light with the water surface of the Komering River and the Perjaya Dam, as well as refraction within the paddy-field irrigation water flow. This product was subsequently validated by six expert validators prior to trial implementation. The expert validation results on the feasibility of the developed module and student worksheets are presented in **Table 2.**

Table 2. Expert Validation Results on the Project-Based Ethno-STEM Learning Model for Optics

No.	Assessed Aspect	Feasibility Percentage (%)
1	Content feasibility	89
2	Instructional suitability	90
3	Language clarity	88
4	Display quality	85
5	Average	88 (Highly Valid)

Table 2 shows that all four assessed aspects obtained feasibility percentages ranging from 85% to 90%, with an overall average of 88%, categorized as highly valid. The instructional

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suitability aspect obtained the highest score (90%), indicating that the developed project-based Ethno-STEM syntax was well aligned with the characteristics of optics instruction and students' needs. The display quality aspect obtained the lowest score (85%); although it still fell within the highly valid category, the validators provided several technical suggestions regarding layout and the clarity of illustrations, which were subsequently addressed through product revision (Huda et al., 2019; Yasin et al., 2020; Putra et al., 2024). These technical suggestions specifically concerned the visual presentation of the STEM-operationalized LKPD tasks described above, namely the instructional diagrams for constructing the simple optical instrument (Engineering), the layout of the light-intensity data-recording tables (Technology and Mathematics), and the clarity of the step-by-step procedures for each local-phenomenon observation task (Science); all of these elements were revised to improve their visual clarity, which is reflected in the display quality score.

The emphasis on observation, reflection, and careful examination also resonates with the Qur'anic encouragement to use human faculties of seeing, hearing, and reasoning to develop knowledge (Qur'an, 16:78). In this study, the high validation scores (85–90%, overall 88%) can therefore be viewed as supporting the suitability of a learning design that directs students toward observing authentic phenomena, organizing evidence, discussing interpretations, and reflecting on their findings. This Qur'anic perspective should be understood as a complementary educational and ethical rationale rather than as empirical evidence for the model's validity; the empirical claim remains grounded in the expert-validation data reported in Table 2.

To provide a more complete methodological summary, Table 3 presents the obtained score, maximum possible score, and the breakdown of scores by validator group for each assessed aspect.

Table 3. Detailed Validation Scores by Assessed Aspect and Validator Group

Assessed Aspect	No. of Items	Max Score (Σxi)	Obtained Score (Σx)	Content Experts (n=2)	Media Experts (n=2)	Instructional Experts (n=2)	Percentage (%)
Content feasibility	8	192	171	60	55	56	89
Instructional suitability	6	144	130	42	42	46	90
Language clarity	6	144	127	42	42	43	88
Display quality	6	144	122	39	44	39	85
Average	**26**	**624**	**550**	**183**	**183**	**184**	**88**

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Regarding the qualitative feedback obtained from the validators, comments centered on strengthening the alignment between local-wisdom examples and the course learning outcomes (content feasibility), simplifying technical terminology for undergraduate readability (language clarity), and improving the visual clarity of instructional diagrams and data-recording tables (display quality); no major revisions were requested for instructional suitability. All feedback was addressed through product revision prior to finalization (Huda et al., 2019; Yasin et al., 2020; Putra et al., 2024).

This finding is consistent with the study by (Sari et al., 2025), who developed a local-wisdom-based STEM e-module in Palembang and obtained a highly valid category, as well as with Rohman et al. (2024), who showed that integrating Ethno-STEM with Project-Based Learning consistently produces highly feasible learning products. The high instructional-suitability score in this study is presumably due to the developed Ethno-STEM-PjBL syntax explicitly relating optical phenomena to local objects familiar to students in OKU Timur. Pedagogically, the reflection and refraction phenomena on the water surface of the Perjaya Dam and the flow of the Komering River enable students to directly observe optical phenomena that had previously only been presented abstractly in the classroom, thereby facilitating the visualization of refraction and reflection concepts and strengthening the connection between scientific concepts and students' real experiences. This is consistent with Yuliana et al. (2023b), who asserted that utilizing South Sumatra's local wisdom as a science learning resource can enhance the relevance and acceptance of learning products among users.

Theoretically, the high validation results for this model also provide an early positive indication of its potential to foster creative thinking, given that projects based on local phenomena require students to explore, design, and test ideas originally (Verawati & Wahyudi, 2024; Zhang & Ma, 2023). This is consistent with the findings of Ariyatun (2021)) and Sartika et al. (2022) that project-based learning integrated with Ethno-STEM contributes significantly to learners' critical and creative thinking skills.

This study has a limitation in that it only covers the development and expert-validation stages, so the model's practicality has not yet been tested through direct classroom implementation, nor has its effectiveness in improving students' creative thinking ability been examined. The subsequent research stage will involve a limited trial with 5 students to assess the model's implementability, as well as an effectiveness test with 20 students using a pretest-posttest control group quasi-experimental design, analyzed using t-tests, N-gain, and Cohen's d effect size (Kraft, 2020) to measure the magnitude of the model's effect on creative thinking ability.

CONCLUSION

An Ethno-STEM learning model based on Project-Based Learning for optics instruction within the local context of OKU Timur has been successfully developed through the analysis, design, and development stages, resulting in a project-based module and student worksheets that were confirmed highly valid by expert judgment, with an overall average feasibility of 88%. Beyond the validation figures, the principal contribution of this study is a transferable pedagogical framework, an Ethno-STEM-PjBL syntax accompanied by practical implementation guidelines, that lecturers can adapt to ground abstract optics concepts in authentic local phenomena, thereby offering a concrete instructional pathway for fostering students' creative thinking in physics education.

Future research is recommended to conduct a limited trial to assess the model's practicality, as well as an effectiveness test through a quasi-experimental design to empirically measure its impact on students' creative thinking ability. Lecturers teaching the Optics course are also advised to consider integrating similar local-wisdom contexts to enhance the relevance and meaningfulness of physics instruction.

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