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Development of a Local Wisdom-Based Guided Inquiry Learning Module to Improve Elementary School Students' Science Process Skills

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Abstract

The project developed and provided a pilot program of an inquiry guided program integrating the environmental issue and local expertise of the Cibanten River to support science process knowledge of the fifth grade elementary students. The research used a research and development methodology in accordance to the stages of ADDIE. The members of the needs analysis were comprised of 19 elementary school teachers, 30 fifth-grade students, and preliminary interviews of three teachers. There were 10 different doctoral-qualified lecturers who were used to validate the module; five subject-matter experts and five media experts. The last test measure was composed of 25 validated dichotomously rated items and was high in the internal consistency (Cronbachs alpha = 0.895). There was a pilot study of 18 fifth-grade students and a field-study of 30 fifth-grade students. The criteria of practicality were assessed through student-response questionnaire and observation of the teaching practice. The first effectiveness was gauged by a one-group pretest-posttest study, N-gain as well as the inferential statistical tests. Aiken had V coefficients of 0.84 and 0.85 with the material and media validations respectively. Student response rate in the small scale trial was 90.93% and in the field trial was 83.50% and the overall rate of instructional implementation was 85.70%. The average score of the field trial was 92.13 as compared with 74.53 representing a high N-gain of 0.73. The improvement was statistically significant, $t(29) = 11.16$, $p < .001$, with a large effect size ($d_z = 2.04$). The science process skills had an overall score of 88.17. The best scores were achieved when relating observations to local wisdom (98.33%), when making investigations (97.50%), but when it comes to predicting or formulating hypotheses the lowest score is obtained (75.00%). These results suggest the validity, practicality, and encouraging preliminary effectiveness of the module. However, additional studies using a control group and larger sample are needed.

Keywords: Cibanten River, Guided Inquiry, Local Wisdom, Science Process Skills, Learning Module

INTRODUCTION

Elementary science education must equip students with the ability to build explanations out of observations, design questions that are investigable, collect and analyze evidence, and communicate. All these actions are usually referred to as science process skills that include observing, classifying, measuring, predicting, inferring, investigating, interpreting data, making conclusions and communicating results. These skills help to fill the gap between the conceptual knowledge and the processes of scientific knowledge production and defense (Harlen, 1999; Jurečková et al., 2024; Wu & Hsieh, 2006). Similarly, Natural and Social Sciences (IPAS) in the elementary curriculum of Indonesia focuses on inquiry, evidence-based thinking, and meaningful interaction with phenomena of the environment instead of memorization of isolated facts (BSKAP Kemendikbudristek, 2022).

Regardless of these expectations, elementary science teaching might continue to be textbook and teacher-directed. Textbooks may indeed be helpful in learning, but not necessarily offer enough chances to students to pose questions, make arguments, and perform systematic research (Chakraborty & Kidman, 2021). The other issue that teachers face is that the curriculum expectation has to be related to accessible inquiry tasks and this is particularly so when the students are different in their prior knowledge and reading levels as well as their independence in learning. Consequently, a body of research suggests that there is a need in instructional resources, which make scientific practices explicit, sequence complex tasks, and provide adequate learning support or scaffolding (Crawford, 2000; Dobber et al., 2017; Quintana et al., 2004).

Guided inquiry is especially suited to elementary students as it is a combination of active inquiry and structured assistance. Inquiry-based learning in science tends to be successful when it involves active participation on the part of the students in terms of engaging the evidence, developing conclusions as based on the data (Furtak, 2006; Minner et al., 2010). Inquiry, however, should not be interpreted to mean the discovery of knowledge, with little guidance. Guiding questions, process worksheets, explanations, feedback and teacher support have been shown through theoretical reviews and meta-analyses to enhance the quality of inquiry and learning outcomes in the context of younger learners or less experienced learners (Alfieri et al., 2011; Hmelo-silver et al., 2007; Kirschner et al., 2006; Klahr & Nigam, 2004; Lazonder & Harmsen, 2016; Mayer, 2004). The recent elementary-school research also suggests that the procedural knowledge and scientific practices among students could be supported with the assistance of planned guidance, need-responsive scaffolding, questioning strategies, and multimedia worked examples (Hu & Chiu, 2024; Kamarudin & Noor, 2024; Sasse et al., 2025; Solé-Llussà et al., 2020).

This support may be operationalized in guided inquiry module which organizes orientation module, question formulation, hypothesis formation, investigation, data interpretation, the determination of the conclusion, communication and reflection in a logical sequence. All these phases are typical of the inquiry cycle that is synthesised in previous research (Pedaste et al., 2015) and the pedagogical frameworks designed to be used in elementary science teachers (van Uum et al., 2016). The module can perhaps relieve the cognitive load that is not relevant, without disengaging the explanation-building process in students in a situation where there are well-defined guiding questions, tables, worked examples, visual materials, and reflection activities (Bell et al., 2010; White & Frederiksen, 2009). The other variable that determines the success of inquiry is whether the learning context being examined is pertinent to the learners or not. Place-based education and environmental science education connect the knowledge gained in the field of the natural environment with the familiar local natural environments, local practices, and local issues.

The natural environment provides an opportunity to strengthen the attention, engagement, sense of place, as well as the ability to apply the knowledge to real life situations (Kudryavtsev et al., 2012; Kuo et al., 2019). Research in the field of environmental education also suggests that, with properly designed local experiences, knowledge, critical thinking, attitudes, and action oriented towards environmental stewardship can be developed (Ardoin & Bowers, 2020; Chawla & Cushing, 2007; Ernst & Monroe, 2004; Monroe et al., 2019; Rickinson, 2001).

The local wisdom extends past the concrete space to the contextual learning in that it acknowledges those values, knowledge and practices through which communities learn about and care of nature. With cross-cultural science education, students are intrigued by attempts to fill the gaps between what they know in their daily life, what they know in their community, and what they learn in school (Aikenhead & Jegede, 1999; Cobern & Loving, 2001; Ogawa, 1995). As the decoration of the culture, the local and Indigenous knowledge cannot be introduced. It can provide a context within which ideas can be compared, evidence needs to be analyzed, debates on sustainability made, and ethical concerns might be critically related to scientific concepts (Bang & Medin, 2010; Meyer & Crawford, 2011; Snively & Corsiglia, 2001; Zidny et al., 2021).

The Cibanten River has the right background of such integration. It has an ecological and social value to the City of Serang and the region. In the meantime, several researches have established the stresses of the pollution attributed to domestic and residential practices, settlements, and other anthropogenic sources. The results of water-quality studies have indicated a high level of pollution parameters in certain areas of observation. These are real world local issues that elementary science activities could pertain to research (Baherem, 2014; Yustiani et al., 2018). One more of the local practices that are introduced in the module developed in the current work is Ngunder Cai, which is an expression of respect of water and the need to take care of the river as a community (Sari, 2025). Students are hence urged to see the river as a source of contaminated water as well as ecological and cultural areas that are directly related to community life.

The previous studies provide a very good background but much more is desired in the development needs as in this case. There is evidence that guided inquiry leads to a better ability of the science process at the elementary and secondary levels (Jurečková et al., 2024; Simsek & Kabapinar, 2010; Suryanti et al., 2020; Yunianti et al., 2019). Positive outcomes have also been achieved by inquiry-based modules and instructional materials (Arantika et al., 2019; Ramdani et al., 2024). In other research, the community knowledge and local settings can be used as a means of teaching science (Nurdiansah et al., 2019; Pranata & Arnyana, 2019; Zidny et al., 2021).

It is these strands of research, however, which are often individually examined. Most of the studies experiment with the impacts of the inquiry models without creating a structured module. Others are the ones who develop inquiry oriented materials, with no specifically observable local environmental issue as the focal point of inquiry. The study of local wisdom has also failed to positively relate cultural contexts to a holistic set of skills of the science process among elementary students. It is on this basis that the research gap can be viewed in the fact that there is not much to do in the sense of elementary modules, which would unite directed aspects of inquiry, a real-life river-pollution problem, as well as local river-knowledge, into a single learning experience. This research paper closes that gap by developing a Grade 5 IPAS course that makes students venture into the Cibanten River, examine the evidence, and correlate their results with the values present in the community, and recommend environmental interventions. Not only is a different site original, but a systematic combination of guided inquiry scaffolding, observable evidence found on the ground, and local cultural meaning is one teaching product. In the light of this, this study would aim at developing the module and its pretest to determine its validity, practicality and initial effectiveness in the development of the skills of the fifth-grade elementary students in the science process.

METHOD

This study employed Research and Development research design that developed and conducted a pilot test of elemental IPAS module. This has been accomplished through the ADDIE process where analysis, design, development, implementation and evaluation of the process has been carried out (Branch, 2009). Research and Development is the option chosen because the study relied on the iterative development of the product, the review of experts, revision, the introduction of the instruction into the classroom and the analysis of the data as compared to the direct testing of the already existing instructional approach (Anderson & Shattuck, 2012; Gall et al., 2003).

A sample of 19 elementary school teachers and 30 fifth-grade students was sampled in the analysis phase. The SDN X, SDN Y and SDN Z in Banten Province, Indonesia were the respondent students. The preliminary interviews of the three teachers of SDN X, SDN Y, and SDN Z include three teachers of the fifth grade. Implementation of IPAS instruction, accessibility and constraints of instructional resources, problems of students in using guided inquiry, problems students had in science process skills and possibilities of the Cibanten River

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as a learning resource were the parts of the analysis. The qualitative data that were used to supplement the findings of the questionnaire were based on interview information instead of being a comprehensive, qualitative investigation on its own.

During the design phase, the results of the needs-analysis and Phase C IPAS Learning Outcomes were converted into components of modules. The module has cover and group identity page, instructions to be followed, learning outcomes and objectives, concept map, environmental pollution information, information on Cibanten River, QR-codes accessed videos, six guided inquiry activities, student worksheets, observation table, reflection activity, and follow-up activity, evaluation questions, glossary, and reference information. The steps of inquiry are orientation; formulating the problem, formulating the hypothesis or prediction, data collection through investigation, hypothesis testing, and interpreting data, and reaching and communicating the conclusion. The aspect of local knowledge is incorporated into narratives about the Cibanten River, environmental care ideologies and Ngunder Cai setting.

During the development, the product underwent tests among 10 doctoral qualified lecturers as well as members of the Faculty of Teacher Training and Education, Sultan Ageng Tirtayasa University, Serang, Banten, and so on. There were five lecturers as subject-matter experts and five as media experts. Accuracy, depth, balance, presentation, meaningfulness, appeal, suitability to the students, and clarity of learning objectives were assessed by the subject-matter experts. The cover design, layout and typography, visual presentation, ease of use, and inclusion of QR-codes and videos, consistency, navigation, and ethical utilization of sources were evaluated by the media experts. The expert ratings analysis was done using Aiken V. Coefficients of close to 1 that depicts more agreement among the experts on the issue content validity (Aiken, 1985). In this study the acceptance criterion was to define a minimum coefficient mean of.80.

Formative revisions were based on expert feedback. Semester and supervisor information were added on the cover, the learning objectives redefined with the assistance of the Audience-Behavior-Condition-Degree model, and the concept map was elaborated, the instructions to the activities were improved in connection with the visual layout, the videos and QR codes were brought up, the comparison between the previous and the current situation with the Cibanten River explained, the Ngunder Cai and the values of environmental-care became more articulate, the river-observation sheet was included, and a follow-up section was added to the end of the conclusion-drawing exercise. The learning-outcome tool was initially created as a 30-item multiple-choice test, which was pretested on 27 sixth-grade students (not a subsample of the implementation group). Item analysis retained a total of 25 valid questions.

The final test blueprint was a representation of six fields of science process skills to include: observing (5 items), classifying (3 items), drawing conclusions (6 items), communicating (6 items), predicting (3 items), and measuring or using numbers (2 items). The 25 items were scored on a dichotomy of an incorrect or correct answer (0 point and 1 point respectively).

The Cronbachs alpha was used to compute internal consistency and was mathematically similar to the KR20 coefficient of dichotomous items. A coefficient of reliability of around.70 or more is said to be acceptable to research instruments but this should be interpreted with consideration to the purpose of the test and the composition of the items (Taber, 2018).

It was done in a small scale trial of 18 fifth-grade students in SDN X and a field trial of 30 fifth-grade students in SDN Y. All the implementations amounted to 140 minutes, doing 4 lesson periods of 35 minutes. Direct observation activities were involved in the field trial of the Cibanten River. Students were involved in group work, module application, following the sequence of inquiry, recording evidence of the environment, describing the patterns that they perceived and their conclusions and recommendations.

Pre-test- post-test design Pre-experimental design Pre-test-posttest one group design was adopted to examine preliminary effectiveness. The lack of random assignment and concurrent control group led to the choice of this design. This pre test was administered before the module-based teaching and post-test administered after the teaching. A student-response questionnaire and observations of instructional implementation were used to evaluate practicality. It was a four point scale questionnaire that was completed by 18 students in Trial 1 and 30 students in Trial 2. Two observers were used to evaluate instructional implementation with the same instrument and it had 28 activities.

The same rubric was used to observe the field trial, with the same objectives of observing, identifying, asking questions, predicting or formulating hypothesis, conducting investigations, collecting data, analyzing data, linking observations to local wisdom, drawing conclusions and communicating results. To ease the classroom observation procedure, Observer 1 looked at students with the numbers 1-15 and Observer 2, who looked at students with 16-30 numbers. The assessors thus rated various students as opposed to rating the same individuals by themselves. The inter-rater reliability was not in that way calculated. There was no identification of other students other than the anonymous numbers in the analysis.

Descriptive summaries were made of qualitative data on the pre-test interviews and product-revision notes. The questionnaires, expert-validation scores, implementation observation and skill observation scores were converted into the percentages or V coefficients of Aiken. The normalized gain (g =(maximum score - pretest)/(posttest - pretest)) was used as the measure of learning gains with low (<.30), moderate (.30-.69), and high (>=.70) being the classification of learning gains. The test of normality of the variation in scores in the paired scores was done using Shapiro-Wilk test. The Wilcoxon signed-rank test was employed since the difference of the scores in Trial 1 was not normally distributed. The standardized paired effect size, d z, and paired samples t test were reported since the mean difference in the scores of Trial 2 was normally distributed. The statistical significance was determined as alpha =.05.

RESULTS AND DISCUSSION

Needs Analysis and the Basis for Product Development

The needs analysis was a strong basis of creating a structured and contextual module. Out of the teachers (n=19), 94.7 was the percentage who felt that they would need a guided inquiry module, 94.7 was the percentage who felt that the Cibanten River provided the right learning experience and 89.5 was the percentage that they would need the instructional resources that would assist learners develop the skills in the process of science. The preliminary interview records indicated that there were three key concerns. First, the materials provided helped to explain the subject matter in question, yet, did not guide investigations in the comprehensive and linear way. Second, data interpretation and conclusion were part of the areas students needed assistance. Third, the teachers did not have instructional materials which they could use readily and which would relate the IPAS material with the river environment around the students.

The needs survey with 30 students formed a general average of 3.44 (out of four) or 86.06. The responses to the individual items, which were positive, were tending towards 80.0 per cent and 100.0 per cent. Over 96.7 percent of the students reported that they positively viewed IPAS learning and the questions regarding the river and the surrounding environment were with a positive attitude between 93.3 and 100.0 percent. These findings lead to the use of a context that is common to the students, and can personally notice. They overlap with the studies of place-based learning that can make the abstract concepts more grounded in reality and involve more attention, participation, and perceived relevance of learning (Kudryavtsev et al., 2012; Kuo et al., 2019; Semken & Freeman, 2008).

The statistics pooled together of more teachers and students reveal that the desired item cannot be a reading material alone. The module ought to guide the learners through each inquiry phase with the help of visual orientation, queries, prediction frames, observation tables, comparison of evidence tasks, and the systematic aid in drawing conclusions 9see

Figure 1). This design principle is in line with the research that the quality of inquiry relies on the orchestration of guidance at each stage and not just the number of hands-on activities completed by the students (Areepattamannil, 2025; Lazonder & Harmsen, 2016; Pedaste et al., 2015).

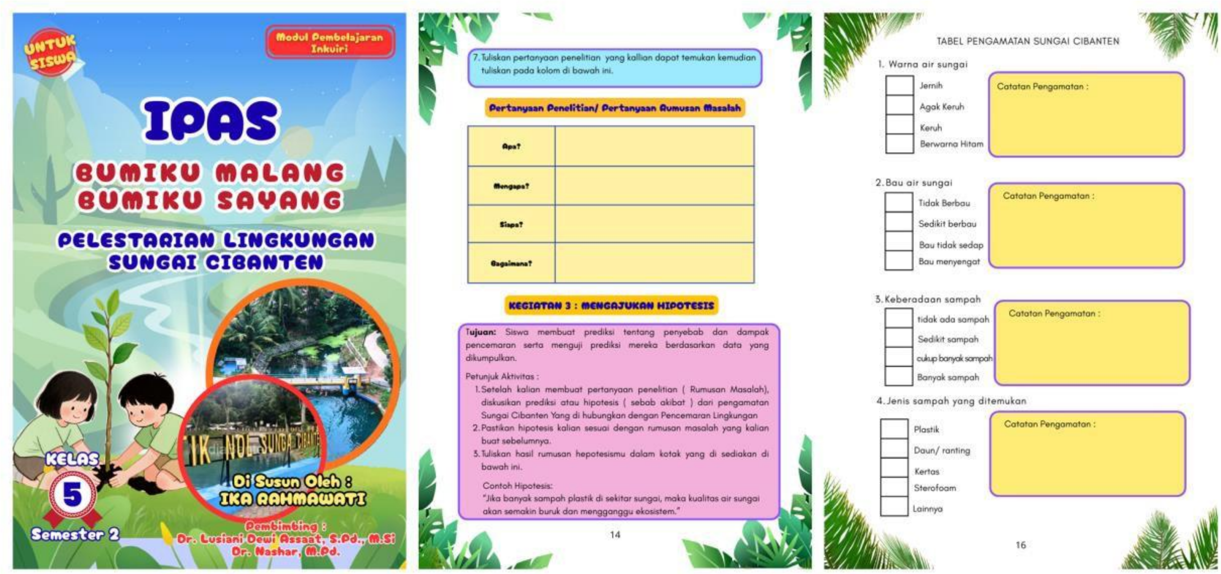

Figure 1. Examples from the final module: cover, hypothesis-formulation guidance, and the Cibanten River observation sheet

Expert Validation and Product Revision

Analysis of the experts showed that the module has met the set criteria of validity. The material was validated with a mean of 0.84 of Aiken V, and 0.85 of media. The most useful value was deemed to be the highest material coefficient (0.95), which justified the choice to relate environmental-pollution concepts to a river familiar to students and which they can research. The content depth and clarity of learning objectives had the lowest material coefficients with 0.75 each. It was the results of these that prompted inclusion of more explicit explanations and quantifiable learning outcomes. The greatest coefficient was obtained in QR-code and video integration (0.97) during the media validation and layout and typography with the lowest coefficient (0.82) in Table 1.

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Table 1. Expert-validation results

Validation aspect	Validators	Aiken's V	Decision	Primary focus of revision
Material	5 subject-matter experts	0.84	Valid	Content depth and measurable objectives

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Validation aspect	Validators	Aiken's V	Decision	Primary focus of revision
Media	5 media experts	0.85	Valid	Layout, typography, instructions, and visual consistency

The trend of validation results signifies that the topicality of the situation is one of the main advantages of the module, and the precision of its educational structure required some fine-tuning. It is a great difference. The culturally or environmentally known material need not always be the effective inquiry material as long as its tasks can not enable the students to ask questions, collect evidence and draw conclusions. The fact that the local knowledge should be linked to scientific activities with the assistance of an adequate pedagogical mediation in order to be taught, rather than being delivered as the cultural information alone, is also emphasized in the teaching of cross-cultural science (Cobern & Loving, 2001; Zidny et al., 2021).

Quality of the Final Test Instrument

The item analysis led to dropping of five out of the 30 questions used, resulting in a final instrument of 25 questions. On the reliability analysis of the response of 27 students there was a value of Cronbach alpha =0.895 and therefore this is an indication that there is high internal consistency. The coefficient is equal to KR-20 since the items were rated on a dichotomous scale. The last blueprint remained to reflect six arenas of science process skills as opposed to emphasizing on factual recall.

Table 2. Distribution of final test items by science process skill

Science process skill	**Item numbers**	**Number of items**
Observing	1, 2, 4, 8, 19	5
Classifying	3, 5, 11	3
Drawing conclusions	6, 7, 9, 13, 16, 20	6
Communicating	10, 12, 18, 21, 22, 25	6
Predicting	14, 17, 24	3
Measuring/using numbers	15, 23	2
Total	-	25

The modelling of several domains of science process competence will address the problems of how science has been evaluated to reward conceptual memory instead of the rationality of practice endeavors. The skills of science process should be apparent in both teaching and evaluation. Students can go through the process of procedures without being aware of how the questions, measurements, evidence, and conclusions are interrelated (Harlen, 1999; White & Frederiksen, 2009). The high coefficient of reliability is a guarantee of consistency of the scores and, however, cannot guarantee that all the science process skills have been evaluated in a balanced way. The instrument preservation in relation to content representation was therefore held by the blueprint of the test (Taber, 2018).

Preliminary Effectiveness Across Two Trial Stages

The small-scale trial showed that the mean score changed to 87.56 as compared to 65.33. The differences between the paired scores were not normally distributed, W =.878, p=.024 and therefore the Wilcoxon signed-rank test was used. The results revealed statistically significant increase, p <.001. Sixteen students had an improvement and the other two got the same score. The average N-gain was 0.58 and it is in the moderate category.

In the field trial, the mean score went up to 92.13 in comparison to 74.53. The difference in the scores met the normality assumption, W =.956, p =.242. It was found that increase was statistically significant (paired-samples t test, t(29) = 11.16, p <.001), with the large standardized paired effect size, d z = 2.04. Twenty-nine students improved and the score of one of the students did not change. The average N-gain was 0.73 which is considered to be high.

Table 3. Pretest-posttest results and preliminary effectiveness

Trial	N	Mean pretest (SD)	Mean posttest (SD)	Mean difference	N-gain	Inferential-test result
Small-scale	18	65.33 (19.01)	87.56 (9.59)	22.22	0.58 (moderate)	Wilcoxon p < .001
Field	30	74.53 (11.19)	92.13 (10.21)	17.60	0.73 (high)	t(29) = 11.16, p < .001; d_z = 2.04

The research and observations data have demonstrated that inquiry-based teaching can reinforce learning when the students can reason on the basis of observations and data (Furtak, 2006; Minner et al., 2010). They are consistent with elementary-school researches that discovered that progress in science process skills was linked to inquiry-based learning and guided discovery (Jurečková et al., 2024; Suryanti et al., 2020). The increased N-gain in the field experiment can be attributed to the modified product and the face-to-face experience activity at the Cibanten River. It was the type of activity which provided real evidence that students could write about. Environmental learning can be based on experience and help attentive students to apply the concepts to real-life scenarios (Ardoin & Bowers, 2020; Ernst & Monroe, 2004).

However, the effect in question can be considered as early efficacy and not causal. A concurrent control group was not incorporated into the study. Moreover, the two trials were conducted in other schools that had different baseline scores and mode of implementation. The module, teacher support, repeated testing, group engagement and contextual learning experiences might have helped in the enhancement of the scores. These restrictions promote the importance of calling the results encouraging early effectiveness rather than the assumption that it was the module that brought about the improvement. A control-group/class-cluster design should be used in further studies, which should examine retention and transition to other environmental courses.

Student Responses and Instructional Implementation

Stage two and stage one of implementation received a very positive reaction of students. Based on Table 4, in the small scale trial, it was 90.93% and in the field trial, it was 83.50%. Trial 1 The module usefulness (93.06%), guided inquiry (92.13%), and local wisdom (91.67%) were the most rated in Trial 1. Trial 2 showed the greatest score of local wisdom (87.92%), and the lowest score of the content aspect (78.33%). All the students were in the positive-answer group. In Trial 1, 17 of the students answered strongly agree and one answered agree. Trial 2: 12 students answered strongly agree and 18 students answered agree.

The field-trial response at the lower level is not to be taken as product failure. The field trial was a more challenging aspect to students as they had to make observations themselves, interpret evidence, and complete the investigation process. The positive score of local wisdom explains that the connection between culture and the environment was still important despite the increase in the difficulty of the learning tasks. The introduction of the right context can lead to an increase in participation, as seen in place-based and culturally responsive science research. Nevertheless, cognitively and linguistically based demands of inquiry are yet to be evident inducing inquiries, readable content, and teacher support equally matched with the students (Meyer & Crawford, 2011; Sasse et al., 2025; Semken & Freeman, 2008).

Based on Table 5, the overall implementation of instructions came to 85.70%. The conclusion stage scored the highest of 93.75 percent and the lowest score was obtained by problem formulation of 79.17 percent. These results indicate that the order of modules could be adopted, overall, during the period of 140 minutes, but there was still a bunch of stages of inquiries that required stronger guidance.

Table 4. Student-response results

Aspect	Trial 1 (n = 18)	Trial 2 (n = 30)
Visual appearance	88.89%	83.75%
Language	89.58%	83.75%
Content	87.50%	78.33%
Guided inquiry	92.13%	82.50%
Local wisdom	91.67%	87.92%
Module usefulness	93.06%	84.38%
Overall	90.93%	83.50%

Table 5. Implementation of the guided inquiry learning stages

Learning stage	Percentage
Opening	84.38%
Orientation	82.50%
Problem formulation	79.17%
Prediction/hypothesis formulation	87.50%
Investigation	83.33%
Data analysis	87.50%
Conclusion	93.75%
Closing	87.50%
Overall	85.70%

The most difficult step was the formulation of a problem whereby the elementary students had to transform a general phenomenon into a confined, researchable question. This would entail conceptual knowledge, knowledge and skills in the foreign language and knowledge of evidence that might be gathered. Inquiry frameworks therefore emphasize the difference between asking questions and making hypotheses, but should be viewed as a mutually dependent process, which requires guide prompts and teacher supports (Pedaste et al., 2015; Quintana et al., 2004; van Uum et al., 2016). The module gave good examples and question stems, which were useful in helping the students, but the findings show that they ought to have more examples in order to compare strong and weak questions, clear requirements concerning the quality of questions and guided modelling in a classroom.

Observed Science Process Skills

Based on Table 6, the mean score of observational science process skills in field trial was 88.17%. The highest scores were in relating findings with local wisdom (98.33%), conducting investigations (97.50%), collecting data (92.50%), and observation (91.67%). The least mark was the prediction or hypothesis formulation (75.00 percent) and even then, there was identification and data analysis, which was scored at 81.67%.

Table 6. Observed science process skills in the field trial

Science process skill	Percentage	Interpretation
Observing	91.67%	Excellent
Identifying	81.67%	Excellent
Asking questions	84.17%	Excellent
Predicting/formulating hypotheses	75.00%	Good
Conducting investigations	97.50%	Excellent
Collecting data	92.50%	Excellent
Analyzing data	81.67%	Excellent
Connecting findings with local wisdom	98.33%	Excellent
Drawing conclusions	90.83%	Excellent
Communicating results	88.33%	Excellent
Overall	88.17%	Excellent

The exceptionally high scores in the investigation and data-collection can be explained by the fact that the module was about an object that can be touched and directly perceived environmental variables, including the color of water, smell, presence of any trash, and activity in the area of a river. The given features could be seen by the students personally and marked in a ready-made table. External representations (table format) reduce the number of observations that should be kept in memory at once and help students to connect different pieces of evidence (Reiser, 2004). The local-wisdom score was high meaning that in the case where the evidence of the environment was clear, the students were able to relate the evidence of the environment to the river stewardship values. This phenomenon is explained by the fact that local and Indigenous knowledge may prove to be an effective mediator between lived experience and formal science when connected with evidence and sustainability as compared to a standalone narrative (Snively & Corsiglia, 2001; Zidny et al., 2021).

On the other hand, predictions and hypotheses cannot be directly observed. Before all the evidence is available, students will need to come up with a plausible relation. This entails their going up a few notches beyond level of describing a condition to conditional reasoning. Previous research indicates that explicit scaffolding to gain an understanding of the hypotheses, variables, and evidence-based explanations is a common activity to be offered to students (Klahr & Nigam, 2004; Sasse et al., 2025; Wu & Hsieh, 2006). The next version of the module would then be more complete in having worked examples, partially worked examples, and sentence structures distinguishing between predictions and conclusion, and promises where the students are expected to justify their predictions on the basis of what they have observed previously.

Contributions, Practical Implications, and Limitations

The major input of this study is that three design elements are synthesized into one elementary instructional product, a guided inquiry format structured, and can be observed directly, an issue of river-pollution, and local cultural significance. The benefits of inquiry, environmental settings, and local knowledge as a single concept have been demonstrated in previous research. The module that has been developed here is the translation of these principles into a full process starting with orientation and results communication. It also provides a practical solution to the needs of teachers; it has prompts questions, worksheets, multimedia resources, and structure of observation. The teachers need not therefore develop the entire inquiry process in the beginning.

The module will be introduced in the classrooms in a facilitative way. Areas where the students usually cannot cope with such things like developing questions, creating hypothesis and data interpretation need to be more supported. A teacher can first give an example and get the students to explain why a question is worth investigating, and less support as the more the groups can do this. This approach aligns with the evidence that successful guided inquiry is a balance between teacher explanation and student autonomy and not direct instruction and inquiry (Areepattamannil, 2025; Hmelo-Silver, 2004; Lazonder & Harmsen, 2016).

This research has a number of drawbacks. To begin with, the pre-experimental design was carried out in the absence of a control group that implies that one will not be able to establish causal relationships. Second, they conducted field trial only on 30 students in one school, and one local condition. Third, the two observers of science-process-skill observed different subsets of students, so there could not be a measurement of inter-rater reliability. Fourth, the researchers failed to evaluate long-term retention, any transfer of the skills to other settings, but they did measure results right after the instruction. Fifth, the local-wisdom element was considered as a part of the learning activities of the module, and was not assessed independently, with an instrument that emphasized cultural knowledge or environmentally oriented attitudes. Future studies based on control groups, several schools and extended implementation times should be informed by these limitations.

CONCLUSION

The current research led to the guided inquiry module, in which environmental issues and Cibanten River local wisdom are used to learn Grade 5 IPAS. Subject-matter and media experts rated the module as valid with Aiken rating it V 0.84 and 0.85, respectively. The final instrument of 25 items scored in the test had good internal consistency (Cronbach alpha = 0.895). The responses and implementation observations of the students revealed that the module was practical in both the trial stages. Field trial The field trial resulted in statistically significant differences in that the mean, pretest was 74.53 with an increased mean, posttest of 92.13 with an N-gain of 0.73 and a large paired effect size. The science process skills were also excellent in general specifically in inquiry, data collection and application of evidence to local wisdom. The most needed scaffolding were in predicting or formulating hypotheses and defining problems. The module could thus be considered as a valid and practical product with high potential initial effectiveness. Its efficiency when compared with other teaching methods though, is yet to be determined by controlled studies involving bigger sample size.

SUGGESTIONS

Control/comparison class should be adopted in future studies, more schools and different environmental settings of the river or other environments should be researching, and delayed retention and transfer of skills to other environments should be investigated. The module should be improved with high-quality questions standards, more samples of hypothesis, clear guidelines to be followed when analysing data, and differentiated support based on reading and reasoning abilities of students. Adequate supervision of river-observation activities and co-ordination between schools and the concerned stakeholders should also be involved. The same design principles may be extended to other elementary issues of IPAS and the local ecological-cultural settings without deeming the pertinent local wisdom to being just a superficial adornment.

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