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DEVELOPMENT OF A TRAINING MODEL TO IMPROVE SCIENCE TEACHERS' COMPETENCE IN DESIGNING *SCIENCE LITERACY* ASSESSMENTS FOR JUNIOR HIGH SCHOOLS

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ABSTRACT

Scientific literacy is a fundamental skill needed to prepare students for 21st-century demands. Despite its importance, Indonesia's 2022 PISA results indicate that students' scientific literacy remains below the international standard, mainly due to teachers' limited ability to design literacy-based assessments. This study aims to develop and evaluate the effectiveness of the Blended Learning for Assessment and Scientific Literacy (BLAST-SCI) model, integrated with a Professional Learning Community (PLC), in improving junior high school science teachers' competence in developing scientific literacy assessments. Using a Research and Development (R&D) approach adapted from the ADDIE framework, the study involved 30 science teachers from Bogor City. Data were collected through observation, interviews, questionnaires, and document analysis, which is analyzed using paired t-tests, N-Gain, ANOVA, and Aiken's V. The findings show that the PLC-integrated BLAST-SCI model significantly improved teachers' competence, as indicated by meaningful pretest–posttest differences ($p < 0.05$), high N-Gain scores (73–84%), and increased instrument validity (Aiken's V = 0.817). Participants gave positive responses to the model's materials, facilitation, and relevance. In conclusion, the PLC-integrated BLAST-SCI model is valid, effective, and practical for professional development, contributing to the enhancement of teachers' assessment literacy and promoting students' scientific literacy through contextual and high-quality assessments.

Keywords: science_literacy; assessment; teacher_professional_development.

INTRODUCTION

Scientific literacy is a crucial competency for preparing students to face the demands of the 21st century. It equips learners with ability to think critically, solve problems, and make evidence-based decisions in everyday life. However, Indonesia's 2022 PISA result indicate that students' scientific literacy remains below the international average, reflecting ongoing challenges in achieving meaningful science learning outcomes.

Assessment plays an increasingly vital role in modern education, particularly for junior high school students (aged 13–15) who are transitioning from learning theoretical concepts to applying them in real-life contexts. In this process, teacher-led assessment serves multiple functions: measuring achievement, providing feedback, diagnosing learning difficulties, motivating students, evaluating both learning and educational programs, supporting placement decisions, ensuring accountability, fostering metacognitive skills, and ultimately improving the quality of learning. Therefore, assessment has literacy becomes a key component in supporting the development of students' scientific literacy.

Despite its importance, many teachers still perceive the implementation of assessments in the Independent Learning Curriculum as a challenge, especially in designing Higher Order Thinking Skills (HOTS)–based questions. Not all teachers fully understand how to apply the assessments types mandated by the curriculum, leading them to rely on simpler forms of evaluation. Several studies have shown that teachers often struggle to design HOTS-oriented assessments due to limited conceptual understanding and practical experience. Consequently, many tend to use lower-level test items that focus on recall and comprehension rather than problem-solving or reasoning skills (Putra, 2018; Astuti & Wiyono, 2023; Mambu et al., 2024). Strengthening teachers' assessment literacy, particularly in designing HOTS-based instruments, is therefore essential to ensure the effective implementation of the curriculum.

One major factors hindering this effort is the limited competence of teachers in developing literacy-oriented science assessments. Many still depend on traditional tests emphasizing factual recall instead to contextual application of scientific concepts. Thus, professional development programs that focus on assessment literacy are crucial to enhance teachers' ability to create valid, relevant, and higher-order assessments.

To explore teachers' experiences with literacy-based assessment practices, a preliminary survey was conducted among 20 junior high school science teachers in Bogor City using an online questionnaire. The data were analyzed descriptively using mean score to identify general trends. The results revealed that teachers rarely participated in training related to scientific literacy assessments development. While most teachers reported being fairly familiar with the concept of scientific literacy, they seldom used instruments specifically designed to assess it. This discrepancy between teacher's self-reported familiarity and their limited engagement in literacy-oriented assessment practices highlights a significant gap in assessment literacy. Similar challenges have also been reported globally (Sampson et al., 2020; Chatterjee & McLeod, 2021).

Based on these findings, the researchers developed and tested a "Training Model for Improving Science Teachers' Competence in Developing Scientific Literacy Assessments for Junior High School Students." This model is expected to help science teachers design and implement assessments that more accurately measure and promote students' scientific literacy, thereby enabling teachers in Bogor City to perform their professional roles more effectively and productively.

The urgency of this research lies in the need to strengthen teachers' competence as the frontline implementers of the curriculum, ensuring that they are not merely transmitters of knowledge but facilitators of scientific thinking. Without targeted training and a well-designed professional development model, teachers may continue to struggle in designing valid literacy-oriented assessment, resulting in learning activities that fail to cultivate critical, analytical, and evidence-based reasoning skills among students. In the long run, this condition could hinder national efforts to enhance students' scientific literacy performance and reduce Indonesia's competitiveness in the global education landscape. Therefore, the development of this training model is not only a response to existing pedagogical challenges but also an investment in the continuous professional growth and human resource quality of science educators.

METHOD

This research employed a Research and Development (R&D) approach aimed at designing and refining a training model that enhances teachers' competence in developing science literacy assessments. The development process was guided by the ADDIE framework— comprising Analysis, Design, Development, Implementation, and Evaluation, to ensure that the model was constructed, tested, and validated in a systematic manner. The resulting model, known as Blended Learning for Assessment and Scientific Literacy (BLAST-SCI), was integrated with a Professional Leraning Community (PLC) approach. This model combines synchronous and asynchronous learning modes, collaborative professional discussions, and continuous formative feedback to promote active and reflective teacher learning.

The analysis phase identified teachers' challenges in implementing science literacy-based assessments. Data were collected through questionnaires, semi-structured interviews, and document analysis of existing assessment instruments. The data were analyzed descriptively and thematically to reveal gaps between current practices and scientific literacy principles. These findings informed the design of the initial BLAST-SCI integrated the PLC framework, emphasizing experiential learning, reflective practice, and peer collaboration.

The design and development phase involved constructing the model framework, preparing learning materials, and developing assessment tools. Expert validation and discussions with science aducation specialists and experienced teachers were conducted to ensure content relevance, structural coherence, and alignment with science literacy principles. Qualitative feedback was analyzed through content analysis to refine and finalize the model components.

The implementation and evaluation phases focused on testing the model's practicality and effectiveness. The model was implemented in a limited trial involving science teachers through blended learning sessions and practice-based workshops. Data

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were collected via observations, reflections, learning logs, performance assessment, and pretest-posttest instruments. Quantitative data were analyzed using descriptive and inferential statistics (paired t-test, N-Gain, ANOVA), while qualitative data underwent thematic analysis to support quantitative interpretations. Evaluation data from feedback questionnaires, interviews, and expert validation sheets (Aiken's V) were used to assess the models practicality and effectiveness as a professional development framework for science teachers.

RESULTS AND DISCUSSION

This study focused on developing a training model designed to enhance teachers' ability to create science literacy-based assessments for junior high school students. The resulting model, named Blended Learning for Assessment and Scientific Literacy (BLAST-SCI), was developed by the researchers as a structured professional development framework that integrates the Professional Learning Community (PLC) approach. The integration with PLC ensure that the training model not only builds teachers' assessment competence but also fosters a collaborative, reflective, and sustainable professional learning culture.

The BLAST-SCI model combines three days of face to face training with online learning sessions within a blended learning format. The online component is facilitated through a simple, integrated Learning Management System (LMS), which fungtions as a medium to support teachers' learning continuity outside the formal training sessions. The LMS is not the core integration of the model but serves as a supporting platform that enables participants to continue discussions, share resources, and collaborate asynchronously in developing science literacy assessments.

The following figure presents the interface of the LMS platform developed in this study. The plafform was designed with a simple, user-friendly interface and includes several main features such as a dashboard, discussions forums, an assessment bank, and a feedback or editing section.

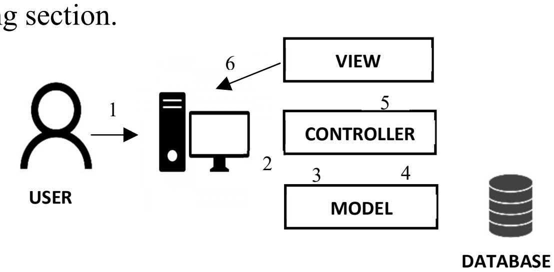

Figure 3. Learning Management System (LMS) Platform for Online Mentoring and Discussion

Whitin this palform, teachers can access and contribute to a bank of assessment items created during the training process. The LMS also provides discussion spaces for inter-group collaboration and an editing feature that allows participants to review and improve each other's assessment designs. These features support the reflective and collaborative spirit promoted by the PLC, enabling teachers to engage in continuous improvement even after the in person training phase.

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Through its integration with the PLC, the BLAST-SCI model emphasizes collective inquiry, reflective dialogue, and share responsibility among teachers in improving literacy-base assessment practices. The combination of structured training sessions and ongoing professional collaboration allows teachers to aplly what they have learned, receive feedback, and refine their practices in real classroom contexts.

The development of the PLC-integrated BLAST-SCI training model was conducted systematically, structurally, and programmatically, following the stages of the ADDIE model—Analyze, Design, Develop, Implement, and Evaluate. Each stage in the development process of the training model is described as follows:

1. Analysis Stage

Questionnaires were distributed online, and the collected responses were summarized and presented in the following pie chart:

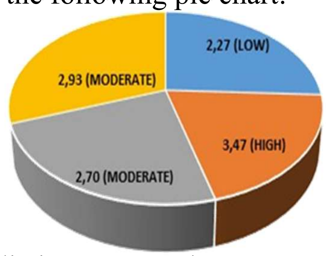

Figure 1. Circle Diagram of Preliminary Research Survey Results (level of familiarity with science literacy, training experience assessment literacy science, frequency of use of science literacy instruments, level challenge in assessment development)

Based on the survey results illustrated in the pie chart above, it was found that junior high school science teachers in Bogor City have a sufficient level of familiarity, experience in science literacy assessment training, and utilization of science literacy–based assessment instruments. However, these teachers face considerable challenges in developing science literacy–based assessment instruments, particularly in terms of content, process, application (context), and attitude. This difficulty arises because many teachers still lack a comprehensive understanding of the essential components that must be included when designing science literacy–based assessments.

Teachers often face challenges in developing science literacy-based assessments due to insufficient understanding of the fundamental components of effective assessment, including the formulation of learning objectives, the construction of higher-order thinking (HOTS) items, and the utilization of assessment data to enhance instructional practices. This aligns with the findings of Isnawati (2022), who reported that teachers' assessment literacy in Indonesia remains relatively low, largely due to limited professional training and practical exposure. Similarly, Supriyadi et al. (2024) emphasized that continuous, collaborative professional development initiatives are critical in strengthening teachers' as'essment competencies.

To address these challenges, an integrated professional development model that combines direct instruction with collaborative learning, such as the Professional Learning Community (PLC) approach is essential. Through PLCs, teachers can collaboratively design and refine assessment instruments, exchange constructive feedback, and engage in sustained reflective practice (IBO, 2023). Consequently, enhancing assessment literacy requires a synergistic framework that blends hands-on training, online learning support, and ongoing professional collaboration.

From the **content perspective**, these challenges occur because science learning materials cover a wide range of topics, including biology, chemistry, physics, and earth and space science, while the allocated instructional time is relatively limited only 40 minutes per lesson in junior high schools. Consequently, science teachers often find it difficult to develop assessments that balance the various scientific domains appropriately. In addition, junior high school science teachers come from diverse educational backgrounds, including biology, physics, and chemistry, which further contributes to the variation in their ability to design comprehensive science literacy assessments.

In terms of the **process aspect**, challenges arise due to the varying abilities of students in understanding science concepts. Consequently, science teachers often struggle to design science literacy assessments that align with students' levels of thinking. Developing assessments that are both fair and suitable for different levels of student ability represents a significant challenge for teachers in fostering science literacy. Moreover, the limited duration of class sessions further constrains teachers' opportunities to conduct practical or experimental learning activities.

Regarding the **application (context) aspect**, challenges emerge because teachers are required to demonstrate a high level of creativity in connecting scientific concepts across disciplines—for instance, linking topics such as heat (physics), ecosystems (biology), and addictive substances (chemistry) to real-life contexts. Additionally, many educational institutions still prioritize multiple-choice tests over essay-based assessments with open-ended responses, project-based evaluations, or case studies, which are more effective for measuring science literacy skills.

From the **attitudinal aspect**, difficulties arise because teachers often find it challenging to differentiate between students' general attitudes and their scientific attitudes within the context of science learning. Furthermore, assessing scientific attitudes such as curiosity, openness to scientific evidence, responsibility, and environmental awareness requires substantial preparation time and classroom implementation. As a result, these assessments are frequently overlooked or evaluated qualitatively without the use of systematic instruments.

2. Design Stage

The of the training model in this study, which applies the BLAST-SCI approach integrated with the PLC framework, is considered relevant because it effectively combines theory, practice, and reflection into a comprehensive and cohesive learning experience. Within this model, teachers as training participants not only engage in individual learning but also participate in collaborative group activities that promote open discussion, mutual feedback, and the strengthening of critical thinking and analytical skills. During the training, science teachers are introduced to key theoretical concepts presented by facilitators or experts, including theories related to scientific literacy, curriculum, the PISA assessment framework, and the principles of developing science literacy–based assessments. After mastering the fundamental concepts, participants proceed to hands-on practice by developing assessment instruments, both individually and through group discussions, where they design context-based questions and construct corresponding assessment rubrics.

The culmination of the BLAST-SCI process, participants engage in reflection activities, reviewing their learning experiences and analyzing challenges encountered throughout the training. Through peer review sessions, as part of the PLC application, teachers collaboratively refine and improve the quality of the assessment instruments they have developed. This stage also enables them to formulate strategies for improvement and plan the implementation of these assessments within their respective schools. Overall, this design is expected to make a tangible contribution to enhancing teacher professionalism and improving the quality of science learning assessments developed by science teachers.

The BLAST-SCI training model integrated with the PLC developed in this study is characterized by four main components:

(a) the application of a blended learning approach that combines face-to-face sessions with online learning activities supported by a Learning Management System (LMS);
(b) training that is participant-centered, emphasizing hands-on practice and reflective activities;
(c) the establishment of a Professional Learning Community (PLC) as a platform for teacher collaboration and the strengthening of professional practice; and
(d) the provision of facilitator feedback to support the continuous improvement of teachers' competencies.

The training program in this study was designed as a three-day intensive workshop. The decision to adopt this duration was based on considerations of efficiency and effectiveness allowing teachers to gain a comprehensive understanding without being away from their teaching responsibilities for an extended period, while also managing costs effectively. The training emphasized the intensive development of teachers' competence in designing science literacy assessments and provided opportunities for participants to directly practice developing science literacy–based assessment instruments through workshop activities.

The detailed activities for each day of the training are described as follows:

a. **Day One:** Focused on orientation, during which participants were introduced to the importance of science literacy assessment in science learning, the fundamental framework of scientific literacy, and the characteristics of assessments aligned with the curriculum and students' learning needs.
b. **Day Two:** Emphasized practical application, where participants were guided to develop their technical skills in constructing science literacy–based assessment instruments.
c. **Day Three:** Centered on reflection, involving a review of the assessment products developed by participants, discussion of challenges encountered during the process, and evaluation of the extent to which the training objectives were achieved.

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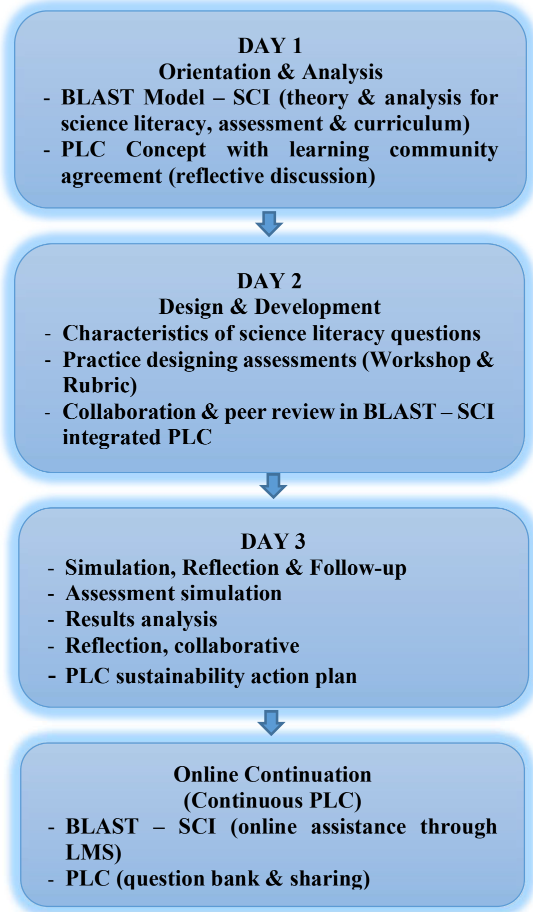

Figure 2. Design of the BLAST-SCI and PLC Training Model

3. Implementation

The implementation of the PLC-integrated BLAST-SCI training model aimed at enhancing science teachers' competence in developing science literacy assessments was conducted over a three-day period. During the training, participants produced science literacy–based assessment instruments that served both as a measure of teachers' performance and as evidence of their improved competence following participation in the integrated PLC BLAST-SCI program.

Quantitative data analysis was conducted using paired t-tests, N-Gain analysis, one-way Analysis of Variance (ANOVA), and Aiken's V tests based on the data collected throughout the study. The results of this study, consisting of assessment instruments analyzed as pretest and posttest data on science teachers' performance in developing science literacy assessments, were examined quantitatively through hypothesis testing using paired t-tests and N-Gain analysis. Based on the paired t-test conducted on eight validation criteria of the science literacy assessment instruments produced by participants before (pretest) and after (posttest) the training, the following hypotheses were tested:

H_0 = There is no significant difference between pretest and posttest scores.

H_1 = There is a significant difference between pretest and posttest scores.

The statistical test results are presented in:

Table 1. Results of the Paired t-Test for Pretest and Posttest Data.

Paired Samples Test				
	Paired Differences	t	df	Sig. (2-tailed)
	95% Confidence Interval of the Difference			
	Upper			
V_1	-2.791	-15.811	5	.000
V_2	-4.135	-12.872	5	.000
V_3	-2.940	-8.730	5	.000
V_4	-3.810	-14.000	5	.000
V_5	-2.925	-15.652	5	.000
V_6	-3.405	-23.000	5	.000
V_7	-2.516	-6.928	5	.001
V_8	-3.583	-11.068	5	.000

Explanation: alignment with science literacy competencies (V1), contextualization or connection to real-life situations (V2), cognitive level C4–C6 (V3), clarity of question construction (V4), consistency of answer options (V5), integration with the curriculum (V6), practical feasibility of implementation (V7), and potential to enhance students' science literacy (V8)

With a significance level of $\alpha = 0.05$ and the decision criterion of "reject H_0 if p-value < 0.05," the analysis results indicated that the p-value was less than 0.05. Therefore, H_0 was rejected, and H_1 was accepted. This finding signifies a significant difference between the pretest and posttest scores, demonstrating that the BLAST-SCI training model integrated with PLC was effective in enhancing teacher competence and positively influenced participants' cognitive understanding.

These results are consistent with the findings of Rubini et al. (2018), which showed that workshop-based professional development can improve teachers' scientific literacy through hands-on experience, discussion, and collaborative practice.

Based on the N-Gain test results comparing the pretest and posttest data across six participant groups, the findings are presented in:

Table 2. N-Gain Test Results for Pretest and Posttest Data.

Group	**Average Pretest**	**Average Posttest**	**Average N-Gain (%)**	**Effectiveness Category**
1	7.4	11.6	83	High
2	7.4	11.0	73	High
3	7.6	11.5	76	High
4	7.5	11.6	83	High
5	7.4	11.5	80	High
6	6.9	11.5	84	High

Note: Effectiveness categories based on Hake's criteria (1998): N-Gain ≥ 70% = "high", 30 ≤ N-Gain < 70% = 'moderate', N-Gain < 30% = "low".

Based on the N-Gain test results, all participant groups showed an improvement in their learning scores. The average N-Gain ranged from 73% to 84%, which falls into the "high" effectiveness category. This indicates that the training had a substantial impact on enhancing participants' mastery of the material delivered. These findings also demonstrate that the implementation of the BLAST-SCI model integrated with

PLC is highly effective in strengthening science teachers' competence in developing science literacy–based assessments.

The BLAST-SCI training model offers opportunities for teachers to progressively build their skills in designing science literacy assessments through a blend of face-to-face and online learning. Meanwhile, the integration with PLC supports collaboration, reflection, and the exchange of best practices among teachers. This finding aligns with the study by Afaf Ahmad Jalaludin et al. (2022), which emphasized that PLC implementation in schools provides teachers with opportunities to work collaboratively in professional teams, share experiences, and reflect on their teaching practices.

Data obtained from observations during the three-day training model implementation were analyzed quantitatively and tested statistically using a one-way ANOVA to determine whether there were significant differences in scores among the groups during the training. The average scores were calculated based on assessments from three observers, with the following hypotheses:
H_0 = there is no significant difference in the mean scores among groups
H_1 = there is a significant difference in the mean scores among groups

Table 3. Results of One-Way Analysis of Variance (ANOVA) on Training Implementation Observations

ANOVA

Source Of Variation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	3.978	5	.796	3.336	.007
Within Groups	31.478	132	.238		
Total	35.457	137			

The results of the ANOVA test indicate a significant difference among the training participant groups ($F(5,132) = 3.336$; p-value = $0.007 < 0.05$). This finding suggests that the training produced varying effects across groups, meaning that the improvement in competence was not evenly distributed. The differences in achievement among groups may be influenced by variations in the teachers' academic backgrounds, which include biology, physics, chemistry, agriculture, and integrated science. These diverse backgrounds contribute to varying levels of prior content knowledge, consequently affecting the pace and depth of participants' understanding during the training process.

Nevertheless, the integration of the PLC approach within the BLAST-SCI model turns these background differences into a source of strength. Through discussions, reflections, and sharing of best practices, teachers from various disciplines can complement one another and broaden their interdisciplinary perspectives. This finding aligns with the study by Rubini et al. (2018), which emphasizes that professional development programs based on science literacy are effective in enhancing teachers' ability to design integrated assessments, even when they come from different academic fields.

Quantitative analysis was applied to the validation data of assessment instruments produced by participants, while qualitative analysis was conducted on questionnaire results, observation notes from the three-day training, and interview findings.

The assessment instruments developed by teachers during the training were validated using the Aiken's V test, based on the following parameters:

Table 4. Parameters of the Aiken's V Test

Parameter	Value	Description
Number of Items (n)	30	
Number of Validators (N)	3	
Lowest Rating Scale (c)	1	(Assuming a Likert scale of 1–4)
Highest Rating Scale (e)	5	
Constant Denominator Value	N(e−c) = 3(4−1) = 9	Maximum value of ∑s

The results of the Aiken's V analysis on 30 pretest and posttest items developed by teachers before and after the training are presented as follows:

Table 5. Summary of Aiken's V Test Results for Item Validation

Validity Category	V Range	Number of Items (Pre)	Number of Items (Post)
Very Valid	V ≥ 0.80	2 (6,67%)	16 (53.33%)
Valid	0.70 ≤ V < 0,80	8 (26.67%)	8 (26.67%)
Needs Moderate Improvement	0.50 ≤ V < 0.70	4 (13.33%)	6 (20%)
Needs Improvement / Low	V < 0.50	16 (53.33%)	0
Total	—	30	30
Average V	—	0.562	0.817

Explanation: V ≥ 0.80 (very valid); 0.70 ≤ V < 0.80 (valid); 0.50 ≤ V < 0.70 (needs moderate improvement); v< 0.50 (need improvement/low)

Based on the validity test results using the Aiken's V coefficient, there was a notable improvement in the quality of the assessment instruments after the training. Prior to the training, only two items (6.67%) were categorized as highly valid and eight items (26.67%) as valid, while 16 items (53.33%) still required major revisions. After the training, the number of highly valid items increased to 16 (53.33%), and the number of valid items remained at eight (26.67%), with the average Aiken's V coefficient rising from 0.562 (needs improvement category) to 0.817 (highly valid category). These findings demonstrate that the BLAST-SCI training integrated with PLC positively influenced teachers' ability to develop valid assessment items.

The results of the validity test for the ten assessment components of the instrument are presented as follows:

Table 6. Recapitulation of Aiken's V Test for the Validation of the 10 Assessment Components of the Assessment Instrument

Assessment Component	Pretest V	Category	Posttest V	Category
Material Relevance	0.767	Moderate	0.993	High
Concept Accuracy	0.600	Moderate	0.641	Moderate
Context Relevance	0.267	Low	0.730	Moderate
Stimulus Quality	0.333	Low	0.689	Moderate
Science Competence	0.456	Moderate	0.730	Moderate
Question Independence	0.633	Moderate	0.726	Moderate

Answer Key	0.989	High	0.989	High
Stimulus Readability	0.500	Moderate	0.744	Moderate
Sentence Clarity	1.000	High	1.000	High
Language Appropriateness	1.000	High	0.996	High
Average Total	0.654	Moderate	0.874	High

The table demonstrates a significant increase in the average Aiken's V score from 0.654 (moderate category) in the pretest assessment to 0.874 (high category) in the posttest assessment after participants completed the training. The most notable improvements were found in the Contextual Relevance component (0.267 → 0.730) and the Stimulus Quality component (0.333 → 0.689), both of which rose from the low to the moderate category after training. Meanwhile, the components of Material Relevance**,** Sentence Clarity**,** and Language Appropriateness consistently showed high validity. These findings indicate that the integrated BLAST-SCI training effectively enhanced teachers' ability to develop assessment items that are more contextual, clear, and aligned with proper assessment standards.

In summary, the observation results suggest that the three-day training model was effective in strengthening junior high school science teachers' competence in improving science literacy, as reflected by the high level of participant engagement. Furthermore, the implementation of a professional learning community and the use of structured training manuals were key factors contributing to the program's success. Nevertheless, the study recommends continued long-term mentoring to ensure that teachers consistently apply and further develop the knowledge and skills acquired from the training, thereby becoming more proficient in implementing science literacy within their respective schools.

Based on interviews with several science teachers who participated in the three-day training implementing the BLAST-SCI model integrated with PLC, it was found that this training approach effectively enhanced teachers' confidence in teaching science literacy. Such confidence is a key indicator of professional growth, as it reflects the teacher's ability to translate newly acquired knowledge into classroom practice (Sims & Fletcher-Wood, 2022; Johari et al., 2022). Moreover, the training provided teachers with a renewed understanding of science literacy—not merely as a concept, but as a tool to foster higher-order thinking and problem-solving skills that are essential in 21st-century education (OECD, 2018; National Research Council, 2021).

However, several challenges were encountered during the training process, such as difficulties in developing appropriate science literacy indicators and the need for sufficient time to internalize the concepts and transform them into applicable teaching skills. These findings are consistent with those of Rubini et al. (2019), which emphasize that teachers require continuous mentoring to sustain and deepen their professional competence.

The questionnaire results revealed highly positive responses from participants, with most indicators categorized as "good." The highest ratings were achieved in the aspects of facilitator clarity (3.73) and science literacy material (3.70), emphasizing the crucial role of facilitator competence in ensuring the success of the training (OECD, 2019).

However, 18.75% of the indicators were rated as “fair,” particularly in the areas of scientific information management (3.13) and training time effectiveness (3.20). These results highlight the need for improvement in analytical skills training and suggest that additional practice time is necessary to maximize participants’ mastery of the material.

In conclusion, the findings indicate that BLAST-SCI-based training integrated with PLC does not produce a uniform impact across all participant groups, but rather varies according to contextual factors within each group. Therefore, follow-up mentoring strategies should be focused on groups demonstrating stronger performance to help reduce disparities between groups.

4. Evaluation

The evaluation phase of the BLAST-SCI training model played a crucial role in assessing the program’s effectiveness in enhancing participants’ conceptual understanding and practical assessment skills. Evaluation data were collected through online questionnaires, direct observations, participant by facilitators and participants. Such a mutli-source evaluation approach is consistent with best practices in professional development evaluation, ensuring both process and outcome validity (Poulou, Reddy, & Dudek, 2023; Online Teacher Professional Development, 2024).

The integration of the BLAST-SCI framework with a Professional Learning Community (PLC) emerged as one of its key strengths. This integration provided a collaborative platform that encouraged reflective dialogue, peer feedback, and share problem-solving, core principles in sustainable professional learning (Loughran, 2019). Through PLC engagement, participants were able to co-construct assessment literacy and contextualize science literacy principles in authentic classroom practice. Moreover, the blended learning design, supported by a simple Learning Management System (LMS), enhanced accessibility and continuity of collaboration beyond face to face sessions. Similar findings were reported by Darling-Hammond et al. (2017), who emphasized that technology-mediated collaboration strengthens teacher agency and engagement in continuous learning.

Despite these advantages, several limitations were identified. The limited duration of practical sessions constrained participants’ opportunities to apply newly acquired skills in designing science literacy-based assessments. Additionally, disparities in digital literacy affected the consistency of online collaboration among participants, a challenge also observed in blended teacher training contexts globally (OECD, 2020). Furthermore, the absence of structured post-training mentoring limited the sustainability of professional interactions within the PLC after the program ended.

Based on these findings, future refinements are recommended. The training module should extend the duration of practice-based workshops and incorporate simulation activities emphasizing data interpretation, assessment analytics, and scientific communication, skills identified as critical for 21st-century scientific literacy

(Sampson et al., 2020). Institutional support is also essential to sustain PLC activities post-training, fostering continuous peer mentoring and reflection. Establishing follow up mentoring mechanisms within school-based PLCs may further enhance the scalability and long term impact of the BLAST-SCI model in improving teachers' assessment literacy and pedagogical practice.

CONCLUSION

This study developed the *Blended Learning for Assessment and Scientific Literacy* (BLAST-SCI) training model, integrating the *Professional Learning Community* (PLC) approach within the ADDIE framework. The model effectively enhanced junior high school science teachers' competence in designing *science literacy*-based assessment aligned with curriculum standards.

Through blended learning, collaborative reflection, and formative feedback, the BLAST-SCI model integrated PLC improve teachers' conceptual understanding and assessment design skills, as reflected in higher posttest and N-Gain scores and positive participant feedback.

Overall*,* the BLAST-SCI model integrated PLC offers an evidence-based framework for teacher professional development that fosters collaboration, reflective practice, and innovation in assessment literacy. Future applications should include extended practical workshops to strengthen teachers' data management and scientific communication skills for sustainable professional growth.

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