Edutec
Journal of Education And Technology
2597-9221 (Online)
Volume 7 Number 2 Desember 2023

Development of Learning Tools Oriented to the BRADeR Learning Model to Facilitate Teachers in Teaching Science Literacy

Asister Fernando Siagian, Rianita Simamora, Aprido Bernando Simamora
Universitas HKBP Nommensen Pematangsiantar, Indonesia
aprido.simamora@uhnp.ac.id

Corresponding Author: Aprido Bernando Simamora

Article History	Received : September 13 2023
	Revision : November 17 2023
	Publication : Des 30th 2023

ABSTRACT

Literacy in science is one of the essential skills needed by students in the 21st century. Teachers require science literacy-based instructional tools to enhance students' science literacy skills. One alternative learning model to improve science literacy skills is the BRADeR learning model. However, there is currently a lack of instructional tools based on the BRADeR learning model. This study aims to determine the validity and feasibility of the instructional tools developed oriented towards the BRADeR learning model to facilitate teachers in teaching science literacy. This research and development study adopts the model proposed by Borg & Gall. The development model consists of three phases: preliminary research, development or prototyping, and assessment phase. Data collection methods for validity and reliability use the Focus Group Discussion (FGD) method, and observation is conducted for lesson feasibility. The developed instructional tools include syllabi, lesson plans, student textbooks, student activity sheets, and science literacy skill tests. The validity of the instructional tools is assessed based on format, content, presentation feasibility, and language for each component. Reliability is analyzed using the percentage of agreement. To determine the ease of use for teachers in implementing the developed tools, the feasibility of lessons conducted by teachers in the classroom is observed. The results of the validity assessment by science education experts indicate that all BRADeR-oriented instructional tools developed fall into the highly valid and reliable category. Observations on the feasibility of lessons conducted by teachers fall into the good category. Thus, it can be concluded that the BRADeR-oriented instructional tools developed can be used by teachers to teach science and enhance the science literacy skills of junior high school students.

Keywords: validity; reliability; feasibility; BRADeR learning model.

INTRODUCTION

Development of scientific literacy and positive attitudes toward science is a primary goal in science education across several countries (Britt et al., 2014; Odegard et al., 2015; Mih & Dragos, 2015; Stuti, 2015; Wang & Zhao, 2016; Vieira & Vieira, 2016; Romine et al., 2017). Students are expected to comprehend the impacts of science and technology in real life, make personal decisions about science and its applications, and actively engage in discussions to critique scientific issues (Fakriyah et al., 2017; Yacoubian, 2018). Equipping students with life skills for innovation, careers, and sustainable development is imperative (Huann et al., 2012; Rahayu 2014). Science-educated students play a crucial role in promoting science literacy in schools and society (Holbrook & Rannikmae, 2009; Odegaard et al., 2014). Therefore, fostering positive attitudes toward science and scientific literacy is crucial for students' success in future life and careers.

The National Science Education Standards (NSES) in NRC (2000) outline six key elements of science literacy: (1) inquiry in science, (2) science content, (3) science and technology, (4) science in personal and social perspectives, (5) history and nature of science, and (6) the unity of concepts and processes. OECD (2019) describes a scientifically literate person as someone capable of explaining phenomena scientifically, designing and evaluating scientific investigations, and interpreting data and facts scientifically. A scientifically literate individual uses scientific knowledge to identify questions, draw conclusions based on evidence, and understand and contribute to decisions about the natural environment and human-induced changes. Scientific literacy, therefore, is a crucial skill for all individuals.

However, the reality is that scientific literacy in Indonesia remains low. PISA research in 2018 reported a science literacy score of 389 (a 14-point decrease from 2015, scoring 403), placing Indonesia 74th out of 79 participating countries (OECD, 2019). Various studies on students' science literacy in different regions of Indonesia also yielded low results (Ardianto & Rubini, 2016; Putra et al., 2016; Fakriyah et al., 2017; Noviana & Julianto; 2018; Rubini et al., 2018). Factors contributing to this low literacy include unsupportive learning processes and the absence of science literacy-based teaching tools. Therefore, the implementation of the BRADeR learning model through developed instructional tools is proposed to enhance science literacy among junior high school students.

To optimize the implementation of the BRADeR model, instructional tools like syllabi, lesson plans, student textbooks, student activity sheets, and literacy tests need to be developed. These tools should undergo validation to ensure their suitability and effectiveness in enhancing students' science literacy. The study aims to validate these BRADeR-based instructional tools, facilitating their use for improving science literacy in junior high school students, aligning with Ratumanan

& Laurens's (2006) recommendation for instructional tools to be minimally valid and user-friendly for teachers.

METHOD

This research is of the Research and Development (R&D) type. The development of the instructional tools in this study adapts the development model proposed by Plomp & Nieven. Plomp & Nieven (2013) present a development model consisting of three phases: preliminary research, development or prototyping, and assessment phase. Data collection involves Focus Group Discussion (FGD) activities and the implementation of the developed instructional tools in teaching.

The validation of the instructional tools is conducted by three expert validators in the field of science education (IPA) by filling out the provided validation sheets. The results of the FGD serve as a reference for revising the developed instructional tools. The data from expert validation are analyzed to determine their validity levels, referring to the criteria in Table 1.

Table 1. Criteria for Instrument Validity Assessment

Score Interval	Assessment Category	Remarks
$3.00 \le P \le 4.00$	Very valid	Can be used without revision
$2.75 \le P < 3.00$	Valid	Can be used with minor revisions
$1.75 \le P < 2.75$	Less valid	Can be used with significant revisions
$1.00 \le P < 1.75$	Not Valid	Cannot be used and requires consultation

(Ratumanan & Laurens, 2006)

To measure inter-rater reliability among validators, the percentage of agreement is analyzed (Borich, 1994). The instructional tools' validation is considered reliable if the percentage of agreement is ≥ 75% (Borich, 1994). The instructional tools are deemed suitable for teaching if the analysis results meet the criteria for high validity and reliability.

Furthermore, to assess the feasibility of the teaching process using the developed tools, the implementation of teaching activities by observing teachers in the classroom is conducted. Observation data are analyzed to determine the level of teaching feasibility according to the criteria in Table 2.

Table 2. Criteria for Assessment of Teaching Activity Feasibility

Score Interval	Assessment Category
$3.50 \le P \le 4.00$	Very Good
$3.00 \le P < 3.50$	Good

Score Interval	Assessment Category
2.50 ≤ P < 3.00	Enough
1.50 ≤ P < 2.50	Not good
1.00 ≤ P < 1.50	Not Good at All

(Arikunto, 2012)

To measure inter-observer reliability, the percentage of agreement is analyzed (Borich, 1994). The results of the observation on teaching feasibility are considered reliable if the percentage of agreement is 75% (Borich, 1994). The instructional tools developed with the aim of facilitating teachers in teaching are known from the results of teaching feasibility to be in the categories of good and very good.

RESULT AND DISCUSSION

The results of this study include an science learning tool oriented to the BRADeR learning model. The developed instructional tools consist of a syllabus, lesson plan (RPP), student textbook (Buku Ajar Siswa), student activity sheets (Lembar Kegiatan Siswa), and a science literacy skills assessment sheet. Before developing the instructional tools, an initial investigation is conducted, involving the analysis of student characteristics, tasks, curriculum, concepts, and learning objectives. The analysis of the syllabus and lesson plans prepared by teachers revealed the adoption of materials downloaded from the internet, while student worksheets (LKS) and textbooks still utilized existing products, and there was no test on science literacy.

The developed instructional tools adhere to the content standards (Mendikbud, 2016a), process standards (Mendikbud, 2016b), and assessment standards (Mendikbud, 2016c) during the development phase or prototype, focusing on the BRADeR learning model. The detailed components of the developed instructional tools oriented to the BRADeR learning model are presented in Table 3 below.

Table 3. Components of the Developed Learning Tools

No	Component	Brief Description
1	Syllabus	Material on Light and Optical Instruments
2	Lesson Plan (RPP)	- Reflection of Light Diffuse and Regular - Reflection of Light in Mirrors - Refraction of Light - Human and Animal Vision - Optical Instruments

3	Student Textbook (BAS)	Introduction - Light and Its Characteristics - Human and Animal Vision - Optical Instruments - Summary of Material
4	Student Activity Sheet (LKS)	- Diffuse and Regular Reflection - Reflection of Light in Concave and Convex Mirrors - Refraction of Light in Prisms - Eye Defects - Microscope
5	Science Literacy Skills Assessment Sheet	- 4 (four) questions for explaining scientific phenomena - 3 (three) questions for designing and evaluating scientific investigations - 3 (three) questions for interpreting scientific data

Setelah perangkat pembelajaran dikembangkan, selanjutnya divalidasi oleh 3 (tiga) orang pakar/ahli dibidang pendidikan sains (IPA). Validasi ini dilakukan melalui suatu rangkaian kegiatan yang disebut dengan *Focus Group Discussion* (FGD). Dalam kegiatan FGD ini, peneliti memaparkan seluruh perangkat pembelajaran yang dikembangkan, kemudian para pakar/ahli memberi masukan dan tanggapan dalam perbaikan perangkat yang telah dikembangkan.

Setelah melalui perbaikan dari masukan serta tanggapan yang diberikan para pakar/ahli pada saat kegiatan FGD, selanjutnya perangkat pembelajaran yang dikembangkan divalidasi oleh para pakar/ahli tersebut. Validasi bertujuan untuk mengetahui tingkat validitas dan reliabilitas perangkat pembelajaran yang dikembangkan. Hasil analisis validasi perangkat pembelajaran, disajikan pada tabel di bawah ini.

Table 4. Results of Learning Tools Validation

No	Learning Tools	Assessed Aspects	Validation Results by Experts					Reliability	
			V1	V2	V3	r	Category	*R* (%)	Expl
1.	Syllabus	Format	4.00	4.00	4.00	4.00	SV	100	Reliable
		Content	3.78	4.00	3.89	3.89	SV	95	Reliable
		Language	4.00	4.00	3.50	3.83	SV	93	Reliable
2.	RPP	Format	4.00	4.00	4.00	4.00	SV	100	Reliable
		Content	4.00	4.00	4.00	4.00	SV	100	Reliable
		Language	3.25	4.00	4.00	3.75	SV	89	Reliable
		Format	4.00	4.00	3.50	3.83	SV	93	Reliable
3.	BAS	Content	4.00	3.86	4.00	3.95	SV	98	Reliable

		Language	4.00	4.00	4.00	4.00	SV	100	Reliable
		Format	3.80	3.80	3.90	3.83	SV	94	Reliable
		Content	3.50	4.00	3.83	3.78	SV	93	Reliable
		Language	4.00	4.00	3.60	3.87	SV	94	Reliable
4.	LKS	Format	3.77	4.00	4.00	3.92	SV	97	Reliable
		Content	3.84	4.00	3.86	3.90	SV	96	Reliable
		Language	4.00	4.00	4.00	4.00	SV	100	Reliable
		Format	3.75	4.00	3.75	3.83	SV	93	Reliable
5.	Tes Literasi Sains	Content	3.80	4.00	4.00	3.93	SV	97	Reliable
		Language	3.90	4.00	3.90	3.93	SV	98	Reliable
		Format	3.80	4.00	4.00	3.90	SV	96	Reliable

Explanation: V = Validator; r = Average; R = Percentage of Agreement; SV = Very Valid

The data presented in Table 4 indicates that the validation results by three validators (experts) for all developed components of the learning tools fall into the category of highly valid. The table also shows that the agreement calculations among validators for all components of the developed learning tools range from 89% to 100%, thereby falling into the reliable category. The agreement among validators suggests consistency in validating the developed learning tools.

The developed syllabus is categorized as highly valid, making it suitable as a guide in developing lesson plans, managing learning activities, and developing learning assessment systems. The validity of the syllabus is attributed to considerations such as consistency of core competencies and basic competencies with Permendikbud No. 14 of 2016, clear elaboration of core topics in line with basic competencies, learning activities facilitating the main learning objective of enhancing scientific literacy, indicator design facilitating the main learning objective, measurable assessment techniques, appropriate allocation of time for subject matter, and presentation of learning resources that are clear and supportive of the learning process. Consequently, the developed syllabus assists teachers in observing, analyzing, and predicting the logical and planned framework of the learning program.

The developed lesson plans (RPP) are categorized as highly valid, making them suitable as a reference for teachers in conducting the learning process in accordance with the main learning objectives. The validity of the lesson plans is attributed to the fact that the development of RPP is based on the previously designed syllabus. Core competencies and basic competencies align with Permendikbud No. 14 of 2016. The formulation of learning indicators aligns with basic competencies. The formulation of learning indicators is classified into the realms of knowledge, skills, and attitudes, including only the observable behavior using operational verbs. Learning objectives are formulated based on indicators (at least one learning objective is formulated for each indicator). The formulation of learning objectives uses the ABCD format (A = audience, B = behavior, C = condition, and D = degree). Learning activities outlined in the RPP are adjusted to the syntax of the BRADeR learning model. The RPP is designed based on the scientific approach, combining it with the BRADeR learning model. The steps of learning are elaborated in detail, including the use of student books, student worksheets, problem-solving skill components, and scientific literacy indicators. Therefore, the RPP can function to optimize the learning process as planned.

The developed Student Textbook (BAS) is categorized as highly valid, making it suitable for use in the learning process with the aim of improving students' scientific literacy. The validity of BAS is highly rated because BAS includes: (1) an introduction that encourages students to construct scientific literacy through natural phenomena in everyday life; (2) the presentation of scientific information before describing scientific concepts, making an effort to capture students' interest in reading BAS; (3) the presentation of concept comprehension tests to solidify the concepts acquired by students during the learning process; and (4) the presentation of scientific applications to enrich students' knowledge about the real-life applications of the learned concepts. The use of BAS in learning is supported by the constructivism theory (Moreno, 2010), which emphasizes the readiness of BAS as an aspect of the learning environment that supports the construction of scientific knowledge and skill development. With the availability of BAS, teachers can determine the scientific concepts to be taught to students and how to teach them so that students can examine and understand the subject matter.

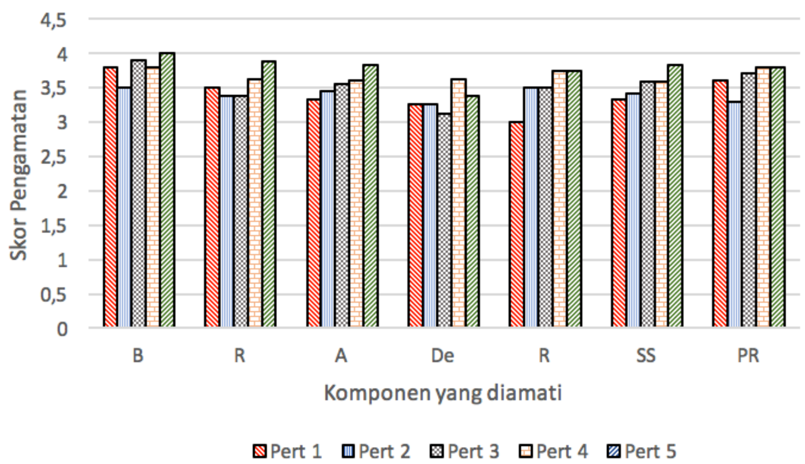
The developed Student Activity Sheets (LKS) are categorized as highly valid, making them suitable for use as supplementary learning materials that support the main learning objectives. The validity of LKS is highly rated because LKS includes: (1) an introductory activity in the form of discourse about everyday occurrences related to scientific concepts; (2) LKS includes indicators so that students are aware of the goals of the LKS activities; (3) LKS includes problem formulation and hypothesis formulation as a reference for students in conducting investigations; (4) Investigation activities are oriented towards designs developed by students; and (5) include evaluation activities for the investigation design. With these various categories of LKS development, LKS can assist teachers in achieving scientific literacy indicators in aspects of designing and evaluating scientific investigation designs. This aligns with the recommendations of Aulia et al. (2018), stating that through inquiry-based learning activities, discussing with a group of peers to identify and formulate problems based on given phenomena, preparing hypotheses, determining experimental variables, experimenting, writing experimental data, analyzing experimental results, and formulating conclusions can improve students' scientific literacy skills.

Table 5. Implementation of Learning

No	Component	Observation Scores					Average	Exp
		RPP 1	RPP 2	RPP 3	RPP 4	RPP 5		
1	Phase: *Brainstorming*	3,80	3,50	3,90	3,80	4,00	3,80	SB
2	Phase: *Reading*	3,50	3,38	3,38	3,63	3,88	3,55	SB
3	Phase: *Analyzing*	3,33	3,44	3,56	3,61	3,83	3,56	SB
4	Phase: *Decision Making*	3,25	3,25	3,13	3,63	3,38	3,33	B
5	Phase: *Reflection*	3,00	3,50	3,50	3,75	3,75	3,50	SB
6	Social System	3,33	3,42	3,58	3,58	3,83	3,55	SB
7	Teacher's Reaction/Behavior	3,60	3,30	3,70	3,80	3,80	3,64	SB

Category: B = Good; VB = Very Good

Observation data regarding the implementation of learning is described in the histogram below.



Explanation: B = *Brainstorming*; R = *Reading*; A = *Analyzing*; De = *Decision Making*; R = *Reading*; SS = Social System; PR = Reacyion Principal

Figure 1. Learning Implementation Histogram

From Table 5 and Figure 1 above, it is obtained that based on the observation results, the overall learning implementation scores an average score on the syntax model components for the Brainstorming, Reading, Analyzing, Decision Making, and

Reflection phases are 3.80, 3.55, 3.56, 3.33, and 3.50, respectively, categorized as good and very good. The social system component scores 3.55 with a very good category, and the teacher's reaction/behavior component scores 3.64 with a very good category. The values obtained from the observation serve as a reference for analyzing the strengths and weaknesses of the learning implementation process, enabling teachers to enhance the learning experience. Thus, it can be concluded that the developed learning tools oriented towards the BRADeR model can facilitate teachers in enhancing scientific literacy.

CONCLUSION

The learning tools oriented towards the BRADeR learning model that have been developed are categorized as very valid. The percentage of agreement (R) from the assessment of the validity of the developed learning tools ranges from 89% to 100%, classified as reliable. The implementation of learning using the developed learning tools is categorized as good and very good, with scores ranging from 3.33 to 3.80. This indicates that the developed learning tools can be used by teachers to facilitate the enhancement of students' scientific literacy skills.

REFERENCES

Ardianto, D. & Rubini, B. (2016). Comparison of students' scientific literacy in integrated science learning through model of Guided Discovery and Problem Based Learning. *Jurnal Pendidikan IPA Indonesia*, 5(1), 31-37.

Asyhari, A., & Clara, G. P. (2017). Pengaruh pembelajaran levels of inquiry terhadap kemampuan literasi sains siswa. *Scientiae Educatia: Jurnal Pendidikan Sains*, 6(2), 87-101

Arikunto, S. (2012). *Dasar-Dasar Evaluasi Pendidikan*. Edisi Revisi. Jakarta: Bumi Aksara.

Aulia, E. V., Poedjiastoeti, S., & Angustini, R. (2018). The effectiveness of guided inquiry-based learning on students' science literacy skills. *MISEIC*, 974.

Britt, M. A., Richter, T., & Rouet, J., F. (2014). Scientific literacy: the role of goal-directed reading and evaluation in understading scientific information. *Journal of Educational Psychologist*, 49(2), 104-122.

Fakriyah, F., Masfuah, S., Roysa, M., Rusilowati, A., & Rahayu, E. S. (2017). Student's science literacy in the aspec of content science? *Jurnal Pendidikan IPA Indonesia*. 6(1), 81-87.

Holbrook, J., & Rannikmae, M. (2009). The meaning of scientific literacy. *International Journal of Environmental & Science Education*, 4(3), 275-288.

Huann, S. L., Zuway, R. H., & Tai, C., H. (2012). The role of emotional factors in building public scientific literacy and engagement with science. *International Journal of Science Education*, 34(1), 25-42.

Menteri Pendidikan dan Kebudayaan. (2016a). *Peraturan Menteri Pendidikan dan Kebudayaan Nomor 21 Tentang Standar Isi Pendidikan Dasar dan Menengah.*

Menteri Pendidikan dan Kebudayaan. (2016b). *Peraturan Menteri Pendidikan dan Kebudayaan Nomor 22 Tentang Standar Proses Pendidikan Dasar dan Menengah.*

Menteri Pendidikan dan Kebudayaan. (2016c). *Peraturan Menteri Pendidikan dan Kebudayaan Nomor 21 Tentang Standar Penilaian Pendidikan Dasar dan Menengah.*

Mih, V., & Dragos, V. (2015). Scientific literacy in school. *Procedia – Social and Behavior Science*, Elsevier. 209, 167-172

Noviana, M., & Julianto, T. (2018). Upaya peningkatan literasi sains siswa melalui pembelajaran berbasis keunggulan lokal. *BIOSFER Jurnal Tadris Pendidikan Biologi*, 9(1), 24-35.

Odegaard, M., Haug, B., Mork, S., & Sorvik, G. O. (2015). Building science and literacy. a classroom video study of the challenges and support in an integrated inquiry and literacy teaching model. *Procedia-Social and Behavioral Science*, Elsevier. 167, 274-278.

OECD. (2019). *PISA 2018 Results: What Students Know and Can Do – Student Performance in Reading, Mathematics and Science (Volume I),* dx.doi.org.

Putra, M. I. S., Widodo, W., & Jatmiko, B. (2016). The development of guided inquiry science learning materials to improve science literacy skill of prospective mi teachers. *Jurnal Pendidikan IPA Indonesia*, 5(1), 83-93.

Plomp, T & Nieveen, N. (2013). *Educational Design Research: An Introduction (Eds)*. Netherlands: SLO

Rahayu, Sri. (2014). *Menuju Masyarakat Berliterasi Sains: Harapan dan Tantangan Kurikulum 2013*. kimia.um.ac.id.

Ratumanan, G. T., & Laurens, T. (2006). *Evaluasi Hasil yang Relevan dengan Memecahkan Problematika Belajar dan Mengajar*. Bandung: CV Alfabeta.

Romine, W. L., Sadler, T. D., & Kinslow, A. T. (2017). Assessment of scientific literacy; development and validation of the quantitative assessment of socio-scientefic reasoning. *Journal of Research in Science Teaching*. 54(2), 274-285.

Rubini, B., Permanasari, A., & Yuningsih, W. (2018). Learning multimedia based on science literacy on the lightning theme. *Jurnal Pendidikan dan Pembelajaran IPA*, 4(2), 89-104.

Simamora, A. B., Sanjaya, I. G. M., & Widodo, W. (2020). Inovative learning model: Improving the students' scientific literacy of junior high school. *International Journal of Recent Educational Research*, 1(3), 271-285.

DOI: https://doi.org/10.46245/ijorer.v1i3.55.

Simamora, A. B., Sanjaya, I. G. M., & Widodo, W. (2022). Validity of BRADeR Learning Model Development: An innovative learning model to improve science literacy skills for junior high school students. *Journal of Curriculum and Teaching,* 11(8), 311-316. DOI:10.5430/jct.v11n8p311.

Stuti, S. (2015). Scientific literacy: science for all. *International Journal of Multidisciplinary Research*, 5(5), 175-180.

Vieira, R. M., & Vieira, C. T. (2016). Fostering scientific literacy and critical thinking in elementary science education. *International Journal of Science and Mathematics Education*, 14(3), 659-680.

Wang, J., & Zhao, Y. (2016). Comparative research on the understandings of nature of science and scientific inquiry between science teachers from shanghai and chicago. *Journal of Baltic Science Education*, 5(1), 97-108.

Yacoubian, H. A. (2018). Scientific literacy for democratic decision-making. *International Journal of Science Education*, 40(3), 308-327.