

ARTICLE

Development of STEAM - PjBL Integrated LKPD on Basic Laws of Chemistry Phase E High School

Nurfadhilla^a, Rahadian Zainul^b

^{ab}Department of Chemistry, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, Jl. Prof. Dr. Hamka, Air Tawar Barat, Padang Utara, Padang, West Sumatera, Indonesia, 25171

*Corresponding email: nurfadhilla008@gmail.com

ABSTRACT

This This research aims to produce teaching materials in the form of STEAM-PjBL integrated LKPD on Basic Chemical Law material that is valid and practical. This research is development research or Research and Development (R & D) and 4-D is the development model. The 4-D model consists of four stages, namely define, design, develop and disseminate. Due to lack of time, this research was only limited to the development stage, namely testing validity and practicality. The instruments used in this research were validation sheets and practicality sheets. The validity test was carried out by 5 validators and the practicality test was carried out by 2 teachers and 10 Phase E students at SMA N 15 Padang. Validity test will be analyzed using the Aiken's v scale formula. Data analysis obtained an average validity of 0.88 with a valid category. Based on the practicality test of teachers and students, respectively, percentages of 93.16% and 91% were obtained in the very practical category. It can be concluded that the STEAM – PjBL integrated LKPD on basic chemistry legal material is valid and practical.

ARTICLE HISTORY

Submission: June 22, 2024

Received: July 12, 2024

Accepted: July 18, 2024

Citation:

Nurfadhilla and
Zainul.Rahadian,
“Development of STEAM-
PjBL Integrated LKPD on
Basic Laws of Chemistry
Phase E High School”,
Chemistry SMART, vol.3,
no.2.pp.74-82
Keywords: Development
LKPD; STEAM-PjBL; basic
laws of chemistry; 4-D
models.

This is an open access article under the [CC-BY](https://creativecommons.org/licenses/by/4.0/) license.



This is an open access article distributed under the Creative Commons 4.0 Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. ©2024 by author.

Corresponding Author :

Nurfadhilla

Faculty of Mathematics and Natural Science, Padang State University, Indonesia

Email : nurfadhilla008@gmail.com

1. Introduction

Education in Indonesia is experiencing rapid dynamics and requires continuous change and improvement in an effort to perfect teaching methods. One aspect that requires improvement is chemistry learning at the high school level [1]. Learning chemistry at the high school level is often faced with challenges, especially in understanding abstract concepts, for example in the basic laws of chemistry, where the basic laws of chemistry are mathematical and abstract, which causes students to experience difficulties in understanding the concepts [2]. A mismatch between the teaching methods or approaches used by teachers and the needs of students can create various challenges in the learning process [3],[4]. Therefore, it is important for educators to recognize and adapt teaching approaches that are in line with students' needs so that the learning process is more effective and meaningful for each student [5],[6].

This STEAM approach not only increases students' understanding of STEAM concepts but also develops 21st century skills such as critical thinking, creativity, communication and collaboration [7],[8]. The integrated STEAM approach with PjBL is a method that combines STEAM learning principles with a project-based approach [9]. The PjBL model is a learning model that focuses on students in finding solutions to problems by understanding learning concepts and implementing them when working on projects. In the PjBL model, students are not only provided with knowledge through a cross-disciplinary approach but are also actively involved in real-world projects [10]. The integration of PjBL into the STEAM approach helps learners prepare to face the complex challenges of the future, where cross-disciplinary understanding and practical skills are needed [11].

PjBL's integrated STEAM approach can be applied in the learning process by using teaching materials, especially LKPD. LKPD with the STEAM-PjBL approach offers innovative and creative learning methods. In this context, LKPD not only functions as a tool for conveying information but also as a guide for students in implementing projects with a STEAM-based approach. For example, LKPD can contain step-by-step instructions to guide students in designing and implementing projects involving aspects of science, technology, engineering, art, and mathematics [12],[13].

The background to the development of LKPD refers to the need to provide structured and guided learning tools for students. In the learning process there is an understanding that students need clear guidance to explore and understand learning concepts independently. LKPD was developed to answer these challenges, with the aim of providing a framework that supports students' understanding through systematically designed tasks, questions and activities [14],[15].

Based on the results of observations with direct interviews with teachers and distribution of questionnaires to students carried out in three schools, namely UNP Laboratory Development High School, N 15 Padang High School and Padang N 12 High School. As a result of data processing from interviews with teachers, information was obtained that in chemistry learning the basic chemistry legal material has implemented an independent curriculum, in the learning process teachers use modules, LKPD and textbooks in learning, teachers use lecture, discussion and demonstration methods in the learning process.

At UNP Laboratory Development High School, the teaching materials used are LKPD, modules, textbooks and PPT. The level of interest of students themselves in the basic laws of chemistry material is not very high, only partially causing difficulties in the application of the questions and students' grades for the basic laws of chemistry material are mediocre. In the process of learning the basic chemical legal material, practicum was carried out but it has been a long time, the application approach in carrying out practicum has been applied but not the STEAM approach.

SMA N 15 Padang obtained information that in the learning process teachers use teaching materials in the form of LKPD, modules, textbooks. Students' own level of interest in basic chemical law material varies and students' scores on basic chemical law material are 50% above average. In the process of learning basic chemical law material, it is rarely done with practicums, the practicum implementation approach has been implemented and the STEAM approach can be applied to this independent curriculum.

SMA N 12 Padang received information that in the learning process the teaching materials used were LKPD, modules, textbooks and PPT. The level of interest of students themselves in the basic laws of chemistry material is not very high, only partly due to difficulties in understanding calculations and students' achievement of average grades in the basic laws of chemistry material. In the process of learning basic chemical law material, practicum is carried out, but there is no time to apply the approach in carrying out the practicum.

Based on the results obtained, it was concluded that the three schools had not used the Project Based Learning (PjBL) learning model in learning basic chemistry legal material. From the results of the questionnaire it can also be concluded that students are less interested in learning basic chemistry legal material. In terms of student scores, only a portion of each class obtained scores above the KKTP, this was because many students had difficulty in the application of questions from the basic chemistry law material itself. In addition, students' own interest in the basic legal material of chemistry is relatively low, namely around 41%.

As research has been conducted [16] regarding project-based learning based on basic chemical law LKPD to improve science skills and student learning outcomes, it was concluded that the LKPD was effective in improving student learning outcomes with an N-gain value of 0.71 in the high category. Starting from this research, an update was carried out by adding a STEAM approach to the development of this LKPD.

Based on the background explanation above, the author is interested in developing a teaching material in the form of "STEAM-PjBL Integrated LKPD on Basic Laws of Chemistry Phase E High School".

2. Experimental

The development carried out in this research uses the 4 D model. The 4D development model refers to a systematic approach, where there are several stages: Define, Design, Develop, and Disseminate [17]. The Define stage involves a clear identification of the project needs and objectives. The Design stage focuses on conceptual design or solutions based on understanding from the

previous stage. Meanwhile, the Develop stage includes implementation and development of products or solutions by detailing the designs that have been created previously. Finally, the Disseminate stage is concerned with implementing this solution in a practical environment or widespread use [18]. However, in this research the dissemination stage was not carried out due to time and cost limitations.

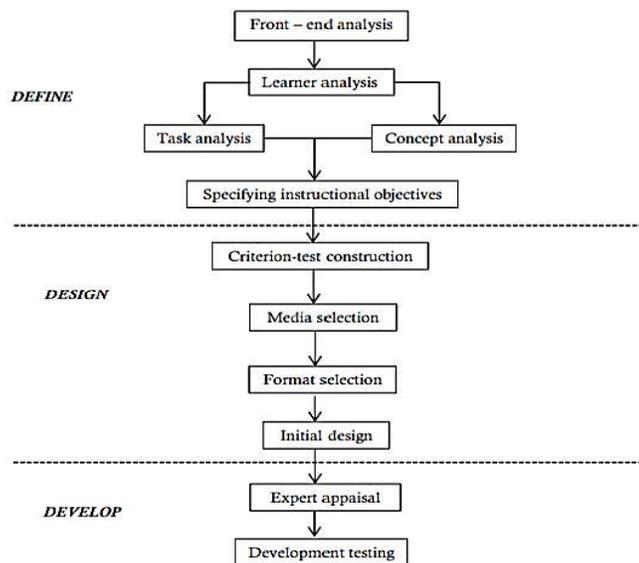


Figure 1. 4-D Development Model View

Data analysis techniques for each research data can be described as follows:

Based on categorical judgments which have been updated by Boslaugh, the validator is given a question, then the validator will provide a value related to the question. The validator's assessment regarding each question is analyzed using the Aiken's V formula [19],[20].

Practicality analysis techniques, practicality is the level of practicality of the research product used by students. This activity was carried out to determine the extent of the benefits, convenience, time efficiency of use, and benefits of media by students [21].

3. Results and discussion

3.1 Validity

The LKPD validation testing was carried out by 3 chemistry department lecturers and 2 chemistry teachers at SMA N 15 Padang. Components assessed at the validation stage include content feasibility components, validity components, presentation components and graphic components [22]. The overall validation results by the validator can be seen in table 1.

Table 1. The Overall Validation

Aspect Assessed	V	Category
Content feasibility components	0.85	Valid
Validity components	0.90	Valid
Presentation components	0.87	Valid
Graphic components	0.90	Valid

The content feasibility component has an average V value of 0.85 with a valid category, meaning that the LKPD developed is in accordance with the decision of the head of the educational standards, curriculum and assessment body. In addition, LKPD combined with the STEAM approach with the PjBL model can improve students' critical thinking skills more quickly [23],[24] because LKPD with the STEAM-PjBL approach offers an innovative and creative learning method which contains step by step instructions for guide students in designing and implementing projects involving aspects of science, technology, engineering, art, and mathematics [12],[13].

The validity component has an average V value of 0.90 in the valid category. This shows that the language used in the LKPD is in accordance with the KBBI, and the instructions and information conveyed are clear [25].

The presentation component has an average V value of 0.87 with a valid category. By obtaining these values, it can be said that the resulting LKPD has been prepared systematically or sequentially in accordance with the TP that has been formulated [26]. The LKPD contains the STEAM approach stages, and there is a project that will be carried out by students where the project will use the PjBL learning stages. LKPD also contains basic chemical legal material concepts as well as images displayed in accordance with the material being taught.

The graphic component has an average V value of 0.90 with a valid category. This shows that the LKPD that has been developed can be read clearly, the layout of the LKPD is orderly and the location of the image illustrations is correct and if you look at it as a whole, the LKPD that has been designed is attractive [27].

Based on the results of the analysis of all aspects, it was concluded that the STEAM-PjBL integrated LKPD on basic chemical legal material that had been developed had a validity level of 0.88 with the valid category.

3.2 Practicality

The practicality test was carried out using an existing practicality questionnaire. To find out the practicality of the product that has been developed, practicality testing was carried out with the help of 2 chemistry teachers and 10 Phase E students at SMA N 15 Padang. In the practicality sheet there are 3 assessment components, namely ease of use, efficiency of learning time and benefits of LKPD. The practicality data results will be calculated with the final result in the form of a percentage.

- a. Results of the practicality of the average teacher respons can be seen in table 2.

Table 2. Practically of the teachers response

Aspect Assessed	NP	Category
Easy to use	87.5%	Very practical
Time effieience	100%	Very practical
Benefits	92%	Very practical

- b. Results of the practicality of the average student respons can be seen in table 3.

Table 3. Practically of the student response

Aspect Assessed	NP	Category
Easy to use	92%	Very practical
Time effieience	90%	Very practical
Benefits	91%	Very practical

Based on the results of processing the teacher's practicality questionnaire in the ease of use aspect, an NP value of 87.5% was obtained in the very practical category and the results of processing the student's practicality questionnaire in the ease of use aspect obtained an NP value of 92% in the very practical category. This shows that the instructions for using the LKPD are easy to understand and contain concise and simple material. With the use of LKPD, it is hoped that students will experience ease in the learning process [28],[29].

Based on the time efficiency aspect of teachers and students, the average NP score is 100% and 90% with the practicality category being very practical. Where learning with LKPD can make learning more effective and efficient [30].

Based on the benefits aspect for teachers and students, the average NP score is 92% and 91% in the very practical category. Thus it can be said that LKPD has benefits for teachers both as facilitators and motivators and the use of LKPD can help students better understand the material through project-based learning [31].

The results of teacher and student practicality assessments show that the STEAM - PjBL Integrated LKPD developed is easy to use, where learning with LKPD is more effective and efficient [30] and LKPD can help students better understand the material through project-based learning [31]. Based on the results of processing the practicality questionnaire in the aspect of ease of use by teachers and students, an average score of 87.5% and 92%, respectively, was obtained in the very practical practicality category. This shows that the instructions for using the LKPD are easy to understand and contain concise and simple material. By using LKPD, it is hoped that students will feel ease in the learning process [28],[29].

4. Conclusion

Based on the results of research, data processing and data analysis carried out regarding the development of the STEAM – PjBL integrated LKPD on basic chemical legal material, it can be concluded that the STEAM – PjBL integrated LKPD on basic chemical legal material developed is valid and practical, with a validity level of 0.88, valid category and the practicality level of the teacher is 93.16% in the very practical category and the practicality level of the students is 91% in the very practical category. The results of the teacher and student practicality assessment show that the STEAM - PjBL Integrated LKPD developed is easy to use, learning time is more efficient and effective, making it easier for students to learn.

References

- [1] Nasution, A.Z.P., & Hindun, H. "Problems of Using Guidebooks in Curriculum 13 and Merdeka Curriculum at Kunciran Elementary School". *Protasis: journal of Language, Literature, Culture and Teaching*, 2(2), 211-219, 2023.
- [2] Abdul, L., Laliyo, R., Gorontalo, U. N., Kilo, J. La, Gorontalo, U. N., Kilo, A. La, & Gorontalo, U. N.. "Students' Ability to Solve Basic Legal Problems". *Ar-Razi Scientific Journal*. Vol. 8 No. 1, 2020.
- [3] Chew, S. L., & Cerbin, W. J. "The cognitive challenges of effective teaching". *The Journal of Economic Education*, 52(1), 17-40. 2021.
- [4] Zhu, Y., & Wang, Y. "Student customized knowledge distillation: Bridging the gap between student and teacher". In *Proceedings of the IEEE/CVF International Conference on Computer Vision* (pp. 5057-5066). 2021.
- [5] Hilaikal, F., Wahyudin, A. Y., & Ayu, M. "The Implementation Of Sq3r In Helping Students'assessment In Reading Class At Sman 1 Adiluwih". *Journal of English Language Teaching and Learning*, 4(1), 53-57. 2023.
- [6] Bernard, R. M., Borokhovski, E., Schmid, R. F., Waddington, D. I., & Pickup, D. I. (2019). Twenty-first century adaptive teaching and individualized learning operationalized as specific blends of student-centered instructional events: A systematic review and meta-analysis. *Campbell Systematic Reviews*, 15(1-2).
- [7] Ganira, L. (2022). Adopting STEAM development strategies in early years education in Nairobi City County, Kenya: Implication for 21st Century Skills. *International Journal on Research in STEM Education*, 4(2), 135-150.
- [8] Putri, A. S., Prasetyo, Z. K., Purwastuti, L. A., Prodjosantoso, A. K., & Putranta, H. (2023). Effectiveness of STEAM-based blended learning on students' critical and creative thinking skills. *Int J Eval & Res Educ ISSN, 2252(8822)*, 8822.
- [9] Permana, N. D., Lestari, I., Harahap, F. D. S., Azhar, A., & Defianti, A. "Project Based Learning (PjBL) Model with STEAM Approach: Its Impact on Students Creative Thinking Skills on Energy in Living System Topic". *Journal of Natural Science and Integration*, 6(2), 186-195. 2020.
- [10] Ellingsen, P., Tonholm, T., Johansen, F. R., & Andersson, G. "Learning from problem-based projects in cross-disciplinary student teams". *Education Sciences*, 11(6), 259. 2021.
- [11] Hsiao, H. S., Chen, J. C., Chen, J. H., Zeng, Y. T., & Chung, G. H. (2022). An Assessment of Junior High School Students' Knowledge, Creativity, and Hands-On Performance Using PBL via Cognitive–Affective Interaction Model to Achieve STEAM. *Sustainability*, 14(9), 5582.

-
- [12] Pramashela, A. D., Suwono, H., Sulisetijono, S., & Wulanningsih, U. A. (2023). The Influence of Project-based Learning Integrated STEAM on the Creative Thinking Skills. *BIOEDUKASI*, 21(2), 138-143
- [13] Wangsa, I. K. K., & Indah, N. K. (2024). Validity of E-LKPD Based on Liveworksheets to Train Science Process Skills on Plant Cell Structure Material. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, 13(1), 197-206.
- [14] Pratiwi, S., Yunarti, T., & Perdana, R. (2023). Developing student worksheet (LKPD) as a problem solving to improve the critical thinking of elementary school students.
- [15] Al Mamun, M. A., & Lawrie, G. (2023). Student-content interactions: Exploring behavioural engagement with self-regulated inquiry-based online learning modules. *Smart Learning Environments*, 10(1), 1.
- [16] Aulia, F. (2023). Development of Project Based Learning-Based Basic Chemical Law LKPD with a Chemo-Entrepreneurship Orientation to Improve Science Process Skills and Student Learning Outcomes at Banjarmasin State High School 5. ULM. Banjarmasin <https://repositori.uhm.ac.id/handle/123456789/42279>.
- [17] Liu, H., Luo, Y., Geng, J., & Yao, P. (2021). Research hotspots and frontiers of product R&D management under the background of the digital intelligence era—Bibliometrics based on citespace and histcite. *Applied Sciences*, 11(15), 6759.
- [18] Syawaluddin, A., Afriani Rachman, S., & Khaerunnisa. (2020). Developing Snake Ladder Game Learning Media to Increase Students' Interest and Learning Outcomes on Social Studies in Elementary School. *Simulation & Gaming*, 51(4), 432-442.
- [19] Muharika, D., & Agus, F. R. (2019). Journal of Information Technology Education, Journal of Information Technology Education, 6(1), 80-86.
- [20] T. T. N. Nguyen, "Developing and validating five-construct model of customer satisfaction in beauty and cosmetic E-commerce," *Heliyon*, vol. 6, no. 9, p. e04887, 2020.
- [21] Asmendri, B. J., Nur, K., Mudinillah, A., & Sari, M. (2022, August). The Validity and Practicality Analysis of Guidebook for the Intra Madrasah Student Organization (IMSO) Activities. In *BIC 2021: Proceedings of the 6th Batusangkar International Conference, BIC 2021, 11-12 October, 2021, Batusangkar-West Sumatra, Indonesia* (Vol. 68). European Alliance for Innovation.
- [22] Sa'adah, R. N. dan Wahyu. (2020). Metode Penelitian Research and Development kajian Teoritis dan Aplikatif. Malang: Literasi Nusantara.
- [23] Halim Simatupang, K., Fauzi, M. A., & Dewi, I. (2023). The Effect Of Project Based Learning Model With Stem Approach To Students'critical Thingking Skill On Human Excretion System. *Jurnal Pelita Pendidikan*, 11(4), 109-120.
- [24] Ilma, A. Z., Wilujeng, I., Nurtanto, M., & Kholifah, N. (2023). A Systematic Literature Review of STEM Education in Indonesia (2016-2021): Contribution to Improving Skills in 21st Century Learning. *Pegem Journal of Education and Instruction*, 13(2), 134-146.
- [25] F. Daryanes, D. Darmadi, K. Fikri, I. Sayuti, M. A. Rusandi, and D. D. B. Situmorang, "The development of articulate storyline interactive learning media based on case methods to train student's problem-solving ability," *Heliyon*, vol. 9, no. 4, p. e15082, 2023
- [26] Sudakova, Natalia E., Tatyana N. Savina, Alfiya R. Masalimova, Mikhail N. Mikhaylovsky, Lyudmila G. Karandeeva, and Sergei P. Zhdanov. 2022. "Online Formative Assessment in Higher Education: Bibliometric Analysis" *Education Sciences* 12, no. 3: 209.
- [27] P. Viitaharju, K. Yliniemi, M. Nieminen, and A. J. Karttunen, "Learning experiences from digital laboratory safety training," *Educ. Chem. Eng.*, vol. 34, no. January 2021, pp. 87-93, 2021.
- [28] Thi Ardiansah, R., & Zulfiani, Z. (2023). Development of interactive e-LKPD based on creative thinking skills on the concept of environmental change. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 9(2), 179-197.
-

- [29] Hardayanti, R., Nurhayati, N., & Suhendi, D. (2019). The Development Of Learner's Work Sheet (Lkpd) In Understanding The Folklore Text Based On South Sumatera Local Wisdom. In *Proceeding Of The International Conference On Literature* (Vol. 1, No. 1, Pp. 947-961).
- [30] Gusyanti, C. (2021). Analysis Analysis Of Student Worksheets (Lkpd) Based On Problem Based Learning On Student Learning Outcomes:. *Jurnal Pendidikan Lldikti Wilayah 1 (Judik)*, 1(02), 47-51.
- [31] Yani, F., & Mulia, M. (2023). Development of STEAM-PjBL integrated worksheet on voltaic cell material to improve the critical thinking skills of class XII SMA/MA students. *Halu Oleo University FKIP Chemistry Education Journal*, 8(2), 83-94