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ARTICLE

Application of TPACK Approach in Developing E-LKPD Based on PBL Model of Atomic Structure Material Phase E High School

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ABSTRACT
Education in the modern era refers to innovative learning using technology and student-centered learning methods. This research aims to produce teaching materials equipped with technology such as E-LKPD using TPACK and PBL approaches for valid and practical atomic structure materials. This study uses a type of Research and Development (R&D) research with the ADDIE model. The research of the ADDIE model consists of five stages such as; analysis, design, development, implementation and evaluation at each stage. With time and cost limitations, this research is limited to the development stage with validation and practicality tests. The validity test was carried out with five media and material experts while the practicality test was carried out with two chemistry teachers and nine students at SMA N 1 Sitiung. The validity test was processed using Aiken'V theory. The average validity analysis results were obtained at 0.92 with the valid category. The analysis of the results of the practicality test of teachers and students was obtained by 91.4% and 84.6%, respectively, which were categorized as very practical. It can be concluded that E-LKPD uses TPACK and PBL approaches for valid and practical atomic structure materials.

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1. Introduction

Education is a forum for increasing knowledge and skills as well as habits that will be passed down from one generation to the next, in preparing a quality generation. In the learning process, there are information exchange activities that include students' understanding in forming broad thinking [1],[2]. This can create character in students, so as educators, teachers must be able to create a school environment that supports, ensures, and inculcates disciplinary attitudes, as well as identifying challenges in learning success [3],[4]. Therefore, the importance of the quality of educators as guides in preparing students who are ready for the demands of education, work or trade such as 21st century learning.

The skills required in 21st century learning comply the ability to adapt, empathy, creativity, and basic techniques in using technology or doing work that cannot be automated, then it is necessary for systematic guidance [5]. The rapid development of technology and information has had many impacts on education, by encouraging the evolution of learning can shape education in a positive direction [6],[7]. In the learning process, combining technology with teaching materials is the right idea [8],[9]. Teaching materials combined with technology can streamline time to make learning more effective and engaging [10]. This is certainly expected to improve the ability of students.

The use of approaches in learning can be used as a solution to improve students' abilities [11]. The TPACK or technology, pedagogy and content knowladge approach is an understanding used by teachers to utilize technology in learning activities, as well as teach material in accordance with the right pedagogical methods [12]. One of the methods that can be used is the PBL model or problem-based learning [13]. The PBL method is considered effective in encouraging the development and improvement of students' critical thinking in determining solutions to a problem individually or in groups [14]. In learning activities, systematic teaching materials are needed to support learning.

Teaching materials encourage students to learn more independently and in using learning resources or references also more widely [4],[15]. One of the teaching materials that can be equipped with technology is E-LKPD. E-LKPD has the advantage of being able to be used with digital devices such as smartphones, computers, laptops, or tablets. Components in the E-LKPD that contain animations, videos, and images as tools in understanding concepts will affect students' motivation in learning [16].

Through observations conducted in three schools in Dharmasraya, it was found that 84.2% of 92 students stated that atomic structure material is boring material. As many in 47.1% of students of SMAN 1 Situng stated that the teaching materials used in learning atomic structures have not helped in understanding the material, and 37% of the students of SMAN 1 Sungai Rumbai and then 51.6% of students of SMAN 1 Kotobaru. From the results of the analysis of chemistry teacher interviews in each school for learning atomic structure material, the teaching materials used are still limited and students are allowed to learn using smartphones so that technology can be applied. Based on the results of observations at the three schools, it can be concluded that there are several problems in learning, especially in atomic structure materials. The lack of motivation of students in learning atomic structures is characterized by low learning outcomes in this material. The LKPD used by teachers as teaching materials has not used technology and there are limited references for students in learning.

Previous research has produced E-LKPD with a PBL model using the TPACK approach for chemical equilibrium material by N. Ardiansyah and Y. Yerimadesi [17] obtaining 0.905 validity and 95% practicality level from teachers and 88% practicality from students. These results show that the E-LKPD developed is categorized as valid and very practical. Another research was also conducted by W.

Purnawati, M. Maison, and H. Haryanto [18] for developing a TPACK-based E-LKPD for temperature and heat materials in physics materials, it was found that the score was 96.42% by media experts, 100% by material experts, then 88.39% of teacher responses and 93% of student responses which were categorized as valid and practical. The development of teaching materials using TPACK was also carried out I. Widiazizah, A. Fatah, and I. Rahayu [19] by developing a mathematics E-Module for rectangular and triangular materials which produced an n-gain value of 0.48 which was categorized as moderate. Then S. Tanjung, Baharuddin, D. Ampera, Farihah, and I. Jahidin [20] also conducted a test to see the influence of learning using the TPACK and PBL approaches which are categorized as active learning and are very satisfactory. Based on these results, the researcher is interested in developing teaching materials in the form of "LKPD using the PBL-based TPACK approach for Phase E Atomic Structure material of SMA/MA". In addition, a validity and practicality analysis was carried out on the resulting E-LKPD.

2. Experimental

The development is carried out using the type of Research and Development (R&D) development with the ADDIE model. ADDIE's research model includes 5 stages starting from analysis, design, development and evaluation [21]. In the analysis stage, an investigation of the initial needs of students will be carried out and the determination of the flow of learning objectives [22]. The second stage is to design the development of E-LKPD by determining the strategy and method to be applied [23]. Furthermore, at the development stage, the design results that have been made at the design stage will be realized [24]. The use of various platforms in the development of E-LKPD such as; Microsoft power point, heyzine flipbook, quizizz, and wordwall. After the E-LKPD is completed, a validity and practicality test is carried out. After being categorized as valid and practical, E-LKPD can be carried out in the Implementation stage where product tests will be carried out in the learning process to determine its effectiveness. Finally, the evaluation stage is analyzed from the results of the implementation stage test which produces data on whether or not a product has been effective. However, this study is limited to the development stage due to time and cost limitations.

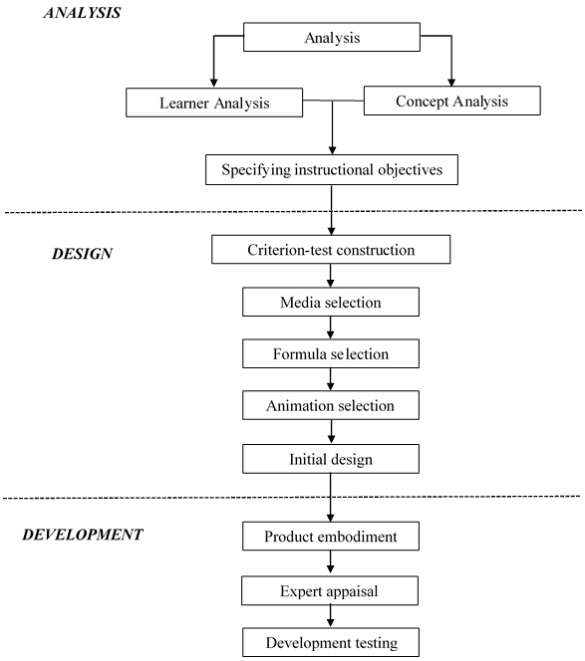

Figure 1. Stages of the ADDIE development model

3. Results and discussion

3.1 Validity

The analysis of the validity of the material and media was carried out with five experts where the data results will be processed using Aiken'V theory. Results obtained with five reters in five categories must get a score of 0.8 to be categorized as valid [25]. The E-LKPD validation test was carried out with three lecturers from the chemistry department of Padang State University and two chemistry teachers from SMA N 1 Sitiung, Dharmasraya. The components assessed include several indicators including content spacing, linguistic components, and graphic components [26],[27]. The overall validation results by the experts can be seen in the table 1:

Table 1. Result of valid analysis

Aspect Assessed	V	Category
Content eligibility	0.92	Valid
Linguistics	0.92	Valid
Graphics	0.93	Valid

The content feasibility component was found to be 0.92 which was categorized as valid with the suitability of learning outcomes with the learning objectives used in the E-LKPD, as well as the suitability of the content of the material, easy-to-understand presentation, and TPACK and PBL-based learning which is useful in increasing students' knowledge and motivation in learning [17],[28].

The linguistic assessment is also classified as valid with a value of 0.92 where the language used in the E-LKPD is in accordance with the rules of Indonesian Language, clear and communicative. Then the graphics component with a value of 0.93 is categorized as very valid in the arrangement of the layout, the adjustment of colors and letters as well as images and videos in accordance with the atomic structure material. From the results of the analysis from all aspects, the use of the TPACK approach in PBL-based E-LKPD for atomic structure materials is classified as valid with an average of 0.92.

3.2 Practicality

After conducting a feasibility test, a practicality test is also carried out. The product will be assessed for practicality by providing a questionnaire with categories (strongly agree, agree, agree enough, disagree and disagree) [29],[30]. The practicality test was carried out with two chemistry teachers of SMAN 1 Sitiung and nine Phase F students who had learned atomic structure during class X Phase E. Components were assessed by looking at the benefits, efficient learning time and easy to use of E-LKPD [31]. The overall results of practicality can be seen in the table 2 and 3:

a. Result of the practicality of the teacher respon can be seen in table 2

Table 2. Assessment results from teachers

Aspect Assessed	NP	Category
Benefit	95.7%	Very practical
Efficient time to study	80%	Practical
Facilities	88.3%	Very practical

b. Result of the practicality of the student respon can be seen in table 3

Table 3. Assessment results from students

Aspect Assessed	NP	Category
Benefit	83.9%	Very practical
Efficient time to study	80%	Practical
Facilities	86.7%	Very practical

The results obtained from the benefit test have a score of 95.7% by teachers and 83.8% by students categorized as very practical, teachers are easier to convey atomic structure material with images and videos presented and by being equipped with structured activities using PBL and the TPACK approach can increase students' motivation in learning.

Judging from the results of the efficiency of learning time, it was found that 80% were categorized as practical. In the implementation of learning using E-LKPD, students will be guided to read each instruction for use so that students will be easy to use E-LKPD and learning time will be more efficient.

From the results of the ease of use of E-LKPD, 88.3% of teachers and 86.7% of students were categorized as very practical. Clear types, sizes and languages have been applied to the E-LKPD, easy-to-understand instructions for use accompanied by components that are active when used. The results of the product's practicality with a score of 91.4% from teachers and 84.6% from students showed that the resulting E-LKPD could affect the success of learning by increasing student motivation [32],[33].

4. Conclusion

The research conducted resulted in E-LKPD based on the TPACK and PBL approaches for atomic structure materials can be concluded to be valid and practical. The validity test results of 0.92 were categorized as valid and the teacher's practicality level was 91.4% with the very practical category and the assessment from students was 84.6% which was also categorized as very practical. The results of the assessment of teachers and students show that E-LKPD using the TPACK and PBL approaches is easy to use with effective and efficient learning time so that it makes it easier for students to learn and understand atomic structures.

References

[1] W. F. Lai and M. Fong, "Use of comparative research in the study of chemistry education: A systematic analysis of the literature," *Heliyon*, vol. 10, no. 1, p. e22881, 2024, doi: 10.1016/j.heliyon.2023.e22881.

[2] M. Mukhibat, "Differentiate Learning Management to Optimize Student Needs and Learning Outcomes in An Independent Curriculum," *QALAMUNA J. Pendidikan, Sos. dan Agama*, vol. 15, no. 1, pp. 73–82, 2023, doi: 10.37680/qalamuna.v15i1.2386.

[3] R. Donkoh *et al.*, "Effects of educational management on quality education in rural and urban primary schools in Ghana," *Heliyon*, vol. 9, no. 11, p. e21325, 2023, doi: 10.1016/j.heliyon.2023.e21325.

[4] A. P. Dewitasari and R. Rusmini, "Feasibility of Interactive E-LKPD Based on Nature of Science (NoS) to Train Students' Critical Thinking Skills on Chemical Bonding Material," *J. Penelit. Pendidik. IPA*, vol. 9, no. 9, pp. 7122–7131, 2023, doi: 10.29303/jppipa.v9i9.4436.

[5] Y. Liu and A. Pásztor, "Effects of problem-based learning instructional intervention on critical thinking in higher education: A meta-analysis," *Think. Ski. Creat.*, vol. 45, no. May, 2022, doi: 10.1016/j.tsc.2022.101069.

[6] W. H. Prasetiyo *et al.*, "Dataset of TPACK in teaching practice: Adversity quotient, attitude computer technology and self-efficacy among Indonesian teachers," *Data Br.*, vol. 45, p. 108749, 2022, doi: 10.1016/j.dib.2022.108749.

[7] C. N. Focacci and C. Perez, "The importance of education and training policies in supporting technological revolutions: A comparative and historical analysis of UK, US, Germany, and Sweden (1830–1970)," *Technol. Soc.*, vol. 70, no. May, p. 102000, 2022, doi: 10.1016/j.techsoc.2022.102000.

[8] G. Falloon, "Investigating pedagogical, technological and school factors underpinning effective 'critical thinking curricula' in K-6 education," *Think. Ski. Creat.*, vol. 51, no. December 2023, p. 101447, 2024, doi: 10.1016/j.tsc.2023.101447.

[9] K. W. Lee, "Effectiveness of gamification and selection of appropriate teaching methods of creativity: Students' perspectives," *Heliyon*, vol. 9, no. 10, p. e20420, 2023, doi: 10.1016/j.heliyon.2023.e20420.

[10] S. Erita, H. Nelda, and F. Ningsih, "Development of Website-Based Worksheets on Flat 3D Shapes Topic," *Tarbawi J. Ilmu Pendidik.*, vol. 18, no. 1, pp. 1–11, 2022, doi: 10.32939/tarbawi.v18i1.1548.

[11] J. van Beurden, I. Borghouts, S. M. van den Groenendaal, and C. Freese, "How Dutch higher HRM education prepares future HR professionals for the impact of technological developments," *Int. J. Manag. Educ.*, vol. 22, no. 1, p. 100916, 2024, doi: 10.1016/j.ijme.2023.100916.

[12] B. Bahtiar, Y. Yusuf, A. Doyan, and I. Ibrahim, "Trend of Technology Pedagogical Content Knowledge (TPACK) Research in 2012-2022: Contribution to Science Learning of 21st Century," *J. Penelit. Pendidik. IPA*, vol. 9, no. 5, pp. 39–47, 2023, doi: 10.29303/jppipa.v9i5.3685.

[13] K. L. Thorndahl and D. Stentoft, "Thinking critically about critical thinking and prob-lem-based learning in higher education: A scoping review," *Interdiscip. J. Probl. Learn.*, vol. 14, no. 1, pp. 1–21, 2020, doi: 10.14434/ijpbl.v14i1.28773.

[14] H. E. Chueh and C. Y. Kao, "Exploring the impact of integrating problem based learning and agile in the classroom on enhancing professional competence," *Heliyon*, vol. 10, no. 3, p. e24887, 2024, doi: 10.1016/j.heliyon.2024.e24887.

[15] B. Aidoo, "Teacher Educators Experience Adopting Problem-Based Learning in Science Education," *Educ. Sci.*, vol. 13, no. 11, 2023, doi: 10.3390/educsci13111113.

[16] S. S. T. Asral and R. Zainul, "Pengembangan Konten Pembelajaran E-Learning untuk Materi Larutan Elektrolit dan Non Elektrolit Menggunakan Aplikasi Moodle," *Entalpi Pendidik. Kim.*, vol. 1, no. 1, 2020, doi: 10.24036/epk.v1i1.92.

[17] N. Ardiansyah and Y. Yerimadesi, "Pengembangan E-Modul Kesetimbangan Kimia Berbasis Problem Based Learning Terintegrasi TPACK untuk Fase F," *Edukatif J. Ilmu Pendidik.*, vol. 6, no. 1, pp. 586–593, 2024, doi: 10.31004/edukatif.v6i1.6362.

[18] W. Purnawati, M. Maison, and H. Haryanto, "E-LKPD Berbasis Technological Pedagogical Content Knowledge (TPACK): Sebuah Pengembangan Sumber Belajar Pembelajaran Fisika," *Tarbawi J. Ilmu Pendidik.*, vol. 16, no. 2, pp. 126–133, 2020, doi: 10.32939/tarbawi.v16i2.665.

[19] I. Widiazizah, A. Fatah, and I. Rahayu, "Pengembangan E-Modul Berbasis Technological Pedagogical and Content Knowledge (Tpack) Dalam Meningkatkan Kemampuan Pemecahan Masalah," *ARITMATIKA J. Ris. Pendidik. Mat.*, vol. 3, no. 2, pp. 95–107, 2022.

[20] S. Tanjung, Baharuddin, D. Ampera, Farihah, and I. Jahidin, "Problem Based Learning (PBL) Model with Technological, Pedagogical, and Content Knowledge (TPACK) Approach," *Int. J. Educ. Math. Sci. Technol.*, vol. 10, no. 3, pp. 740–752, 2022, doi: 10.46328/ijemst.2510.

[21] A. G. Spatioti and I. Kazanidis, "A Comparative Study of the ADDIE Instructional Design Model in Distance Education," pp. 1–20, 2022.

[22] H. R. Saeidnia, M. Kozak, M. Ausloos, and C. Herteliu, "Development of a Mobile App for Self-Care Against COVID-19 Using the Analysis , Design , Development , Implementation , and Evaluation (ADDIE) Model : Methodological Study Corresponding Author :," vol. 6, no. 9, pp. 1–14, 2022, doi: 10.2196/39718.

[23] D. M. Abdillah and D. Astuti, "Pengembangan lembar kerja peserta didik (LKPD) berbasis problem-based learning (PBL) pada topik sudut," *Pythagoras J. Pendidik. Mat.*, vol. 15, no. 2, pp. 190–200, 2021, doi: 10.21831/pg.v15i2.36444.

[24] M. Kawete, D. Gumolung, and A. Aloanis, "Pengembangan Video Pembelajaran Materi Ikatan Kimia denganModel ADDIE Sebagai Penunjang Pembelajaran di Masa PandemiCovid-19," *Oxyg. J. Chem. Educ.*, vol. 4, no. 1, pp. 63–69, 2022, doi: 10.37033/ojce.v4i1.374.

[25] F. Gusman, I. Dewata, A. Andromeda, and R. Zainul, "Development of Problem Based Learning Based E-Modules on Salt Hydrolysis Materials to Improve Students Science Literature," *J. Penelit. Pendidik. IPA*, vol. 8, no. 5, pp. 2410–2416, 2022, doi: 10.29303/jppipa.v8i5.1831.

[26] L. Lestari, H. Alberida, and Y. L. Rahmi, "Validitas dan Praktikalitas Lembar Kerja Peserta Didik (LKPD) Materi Kingdom Plantae Berbasis Pendekatan Saintifik untuk Peserta Didik Kelas X SMA/MA," *J. Eksakta Pendidik.*, vol. 2, no. 2, p. 170, 2018, doi: 10.24036/jep/vol2-iss2/245.

[27] L. Vinca Rosea Cristy and F. Ditawati Nur Pamenang, "Development of ethnoscience-based student worksheets of redox reactions, volta cells, and corrosion using liveworksheets," *J. Pendidik. Kim.*, vol. 15, no. 3, pp. 182–190, 2023, doi: 10.24114/jpkim.v15i3.51211.

[28] C. C. A. Dewi, J. M. Kusuma, P. Pahriah, and W. Syahri, "Pengembangan Modul Digital pada Materi Struktur Atom untuk Menumbuhkan Literasi Digital Siswa," *J. Indones. Soc. Integr. Chem.*, vol. 14, no. 2, pp. 84–89, 2022, doi: 10.22437/jisic.v14i2.19930.

[29] L. Hanum* *et al.*, "Development of Learning Devices Based on Ethnoscience Project Based Learning to Improve Students' Critical Thinking Skills," *J. Pendidik. Sains Indones.*, vol. 11, no. 2, pp. 288–305, 2023, doi: 10.24815/jpsi.v11i2.28294.

[30] R. Rosalia and S. Suryelita, "Development of Worksheet Based Problem Based Learning (PBL) in Colloidal Systems For Senior High School," *Entalpi Pendidik. Kim.*, pp. 8–16, 2021, doi: 10.24036/epk.v2i4.148.

[31] S. A. Nisa, M. S. Silaban, and S. Silaban, "Development of chemic media (chemistry comic) based on problem based learning on chemical bond materials for class x students," *J. Pendidik. Kim.*, vol. 14, no. 1, pp. 39–46, 2022, doi: 10.24114/jpkim.v14i1.32112.

[32] 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, doi: 10.1016/j.heliyon.2023.e15082.

[33] M. Mariyana, W. Syahri, and H. Haryanto, "Based E-LKPD development based problem based learning to improve students' creative thinking skills on acid-base material," *J. Pendidik. Kim.*, vol. 15, no. 2, pp. 163–169, 2023, doi: 10.24114/jpkim.v15i2.48264.