International Journal of Academic Pedagogical Research (IJAPR)
ISSN: 2643-9123
Vol. 7 Issue 1, January - 2023, Pages: 39-44

Integrated STEAM-PjBL LKPD Development in Electrochemical Cell Materials for Senior High School Grade XII

Amelia Kontisa*[1], Effendi[2], Irfan Ananda Ismail[1]

Program Studi Pendidikan Kimia Universitas Negeri Padang, Indonesia

Jurusan Kimia Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Negeri Padang, Padang, Indonesia

akontesa47@gmail.com

Abstract: *"This research aims to develop a teaching material in the form of a Student Activity Sheet (LKPD) Integrated Science, Technology, Engineering, and Mathematics-Project Based Learning (STEAM-PjBL) on the material of Electrochemical Cells and is used to determine the validity level of the LKPD in terms of content and construct validity and the practicality of the developed LKPD. This research is a Research and Development (R&D) development study using the 4-D model. In this 4-D model, there are four stages, namely the define stage, the design stage, the develop stage, and the disseminate stage. However, this research was carried out until the Develop stage because the disseminate stage was not carried out due to time constraints. This research uses instruments in the form of a validity content and construct questionnaire, a teacher and student response questionnaire. The LKPD was validated by five validators, including chemistry lecturers at FMIPA UNP and chemistry teachers at SMAN 6 Padang in the 2021/2022 academic year. The validation data obtained were analyzed using Aiken's v scale, while the practicality data were analyzed using a comparison of students' scores with the maximum student score. Based on the analyzed validation questionnaire, it can be concluded that the developed LKPD is valid with a value of 0.915 in the valid category. Meanwhile, the practicality of teachers and students obtained a score of 94% and 89% respectively, with a very practical category."*.

Keywords: Electrochemistry Cell, LKPD, Model 4-D, STEAM-PjBL

PENGANTAR

Education is a field that has a great influence in the process of creating a quality Human Resources (HR). In facing the challenges of the 21st century, several programs have been prepared, namely 4C (Critical Thinking, Communication, Collaboration, Creativity) (Sugiyarti, et al., 2018). Ministry of Education and Culture Regulation No. 36 of 2018: Changes to Ministry of Education and Culture Regulation No. 59 of 2014 stated that the 2013 Curriculum develops learning experiences that provide a wide opportunity for learners to master competencies that are very useful for the present and future life (Ministry of Education and Culture, 2018). Some examples of 21st century skills are critical thinking skills, problem solving, creativity, communication, and STEAM literacy. STEAM (Science, Technology, Engineering, Art and Mathematics).

This learning approach pays great attention to the development of soft skills in students because it has linked the fields of science (science), technology, engineering, art, and mathematics, so that students are given a holistic understanding of the relevance of these fields. science through 21st century learning experiences. Learning with the STEAM approach is contextual learning (Yakman, 2012), where students are invited to understand the phenomena that occur close to themselves. PBL is one of the learning models that can be integrated with STEAM because the PBL model in its implementation is in line with the STEAM approach, because in its implementation PBL must follow the principles of Science, can be integrated with technological engineering art and mathematics.

Cooperative project-based learning or PBL model is a model developed based on the implementation of a project involving students in investigating real-world problems through cooperative groups (Yam & Rosini, 2010). Implementing project-based learning is one of the ways that you as a teacher can involve students with their learning material or content. This model with a project is considered attractive because it has an innovative instructional format where students can choose various aspects of assignments and are motivated by environmental issues that can even contribute to them (Bender, 2012)."

The success of a learning depends on the model and teaching materials applied by a teacher in the learning process in the classroom. LKPD is one of the teaching materials that contains tasks and work steps that must be carried out by learners so that they can learn independently with teacher guidance (Prastowo, 2011). Moreover, the 2013 curriculum is required to be active and able to work independently. The appropriate means to support learners to be active and independent in learning is LKPD. The LKPD developed with the 4-D development model in chemistry material that can be

applied to STEAM-PjBL is Electrochemical Cell material.

Electrochemical Cells is one of the main chemistry subjects studied by learners in grade XII in the second semester. In the learning of Electrochemical Cells, learners can produce a product related to daily life, such as making a battery circuit from several pieces and metal plating from floor cleaner and so on. By producing a product, it is expected that learners will understand the material of Electrochemical Cells better. Based on data obtained from initial observations at several schools, namely SMAN 1 Padang, SMAN 6 Padang and SMA Adabiah 2 Padang, it was obtained that at the three schools they already use LKPD, but the LKPD usually used in chemistry learning is only a summary of the material and practice questions have not yet been integrated using the STEAM approach with the PBL model. In addition, the level of difficulty of Electrochemical Cells material according to learners is quite high, namely 68% of 66 learners. Based on the explanation above, this occurs because the learning is done online so that learners find it difficult to understand the learning given by the teacher, besides the use of lecture methods that tend to be carried out by teachers make learners quickly bored in learning. Therefore, this research aims to produce an LKPD oriented to STEM with the PBL model of Electrochemical Cells by utilizing materials around that are suitable for application in good chemistry learning..

METHOD

The type of research conducted is R&D (Research and Development) in this research, a product in the form of a Student Activity Sheet (LKPD) integrated with STEAM-PjBL (Science, Technology, Engineering, Art and Mathematics) on Electrochemical Cell material is developed. The Development Model used in this research is the 4-D model consisting of 4 stages, namely: define, design, develop, and disseminate (Thiagarajan, et al., 1974). However, this research was carried out until the Develop stage because the disseminate stage was not carried out due to time constraints. The subjects in this study are 3 chemistry lecturers from FMIPA UNP, 2 chemistry teachers from SMAN 6 Padang, and students from SMAN 6 Padang.

1. Definition stage (Define) The define stage is carried out to determine or define the requirements needed in the development of learning. In general, in this definition, an analysis of development needs, development product requirements according to user needs, and appropriate research and development (R&D) models are carried out for product development. The steps of activities in the define stage are front-end analysis, learner analysis, task analysis, concept analysis and learning objectives formulation.
2. Design stage This stage aims to design teaching materials in the form of LKPD based on STEAM PBL on Acid-Base Solution material based on Basic Competence (KD). Design or design is the second stage in the 4-D development model.
3. Development stage The development stage aims to produce valid and practical LKPD based on STEAM PBL on acid-base solutions for use in learning activities. This stage consists of three steps, namely validity testing, revision and practicality testing.

The instrument used in this study is a validation sheet and a practicality questionnaire. Validity analysis is carried out based on modified Boslaugh's (2008) categorical judgments. In categorical judgments, validators will be given a questionnaire containing questions then validators will provide assessments for each question based on the developed product. The assessment from all validators will be analyzed using the Aiken's V formula which can be seen in the equation and Aiken's V scale categories in Table

$$\boldsymbol{V} = \frac{\sum s}{n(c-1)} \; where \; s = r - l0$$

Explanation: s = score set by validator minus the lowest score used; r = validator's choice category score; l0 = lowest score in the scoring category (l); n = number of validators; c = number of categories selected by validator.

Tabel 1

Aiken's V scale category

***Aiken's V* Scale**	Kategori
V < 0,8	Tidak valid
V > 0,8	Valid

Nugroho dan Ruwanto (2017)

After the LKPD is declared valid, the next step is to test its practicality. This test will be conducted on teachers and students. The purpose is to determine whether the resulting LKPD is practical or not. The results of the practicality test will be analyzed using a modified equation by (Purwanto, 2010) and analysis using equation 2 and categories of practicality level in table 2.

$$NP = \frac{R}{SM} x100\%$$

Explanation: NP = Percent value being sought or expected; R = Raw score obtained from students; SM = Total ideal score in 1 item.

Tabel 2

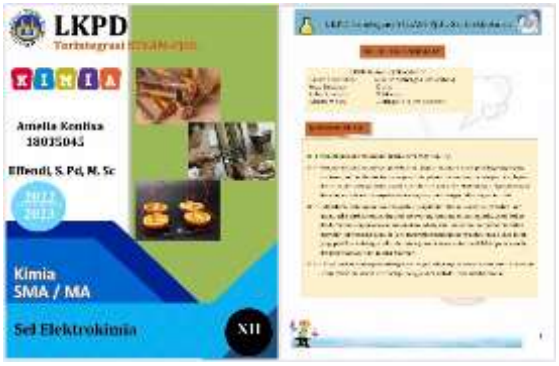
Practicality Category Level

Nilai (%)	Kategori

86 – 100	Very Practice
76 – 85	Practice
60 – 75	Enough
55 – 59	Less
≤ 54	Not

III. Result and Discussion

The result of the research conducted is a product in the form of an Integrated STEAM-PjBL (Science, Technology, Engineering, and Mathematics-Project Based Learning) Student Activity Sheet (LKPD) on Electrochemical Cell material. The research used the Research and Development (R&D) type of research with the 4-D development model consisting of four stages: define (definition), design (planning), develop (development), and disseminate (dissemination).



Gambar 1. LKPD yang dikembangkan

The Define phase

This phase is carried out to determine and define the needs and requirements for learning. This phase obtains 5 data, based on end-front analysis, learner analysis, task analysis, concept analysis, and learning objective formulation.

1. End-front analysis This analysis is used to uncover and establish the basic problems in the Sel Electrochemistry learning material. The problems are obtained from observations made through direct observation or interviews with 3 chemistry teachers using questionnaire surveys from SMAN 1 Padang, SMA Aabiah 2, and SMAN 6 Padang.
   Based on the observations that have been made, several problems were obtained, including:
   a) In the implementation of Sel Electrochemistry learning material, the scientific approach and STEAM (Science, Technology, Engineering, and Mathematics) approach are still being applied, while the STEAM approach has not been applied. b) The learning models used are guided inquiry, problem-based learning, and discovery learning. There is no implementation of PjBL (Project Based Learning) as a learning model.
   c) There are still Sel Electrochemistry material that is not understood by students.
   d) The LKPD used is not colorful, has too much text, has no pictures, and is not integrated with STEAM-PjBL that can improve the 4C abilities, namely creativity, critical thinking, collaboration, and communication.

a. Student Analysis

This analysis is conducted to analyze the characteristics of students. These characteristics include the background, abilities, and motivation of students. The results of the analysis are presented to 60 students in grade XII MIPA SMA. Based on the questionnaire results, the following characterization of students was obtained: a)

a) 57% of the learners consider that they do not understand some of the material because the learning is still centered on the teacher, so their critical thinking is not well trained. b)
b) 79% of the learners like to learn using LKPD that makes it easier for learners to understand the concept of Sel Electrochemistry material. c)
c) 87% of the learners like to learn using colorful LKPD. Based on the questionnaire results given to the students, there is a need for LKPD that is attractive, able to facilitate student understanding of the concept, and able to develop student creativity..

c. Task Analysis

Task analysis aims to identify and analyze the abilities that students must master through the determination of content in a lesson that is in accordance with the 2013 revised curriculum 2018. This analysis can be in the form of Basic Competency (KD) and lesson material analysis. Furthermore, the IPK formulation is in accordance with the KD (3.4), (4.4), (3.5), (4.5), (3.6), (4.6). Based on the KD, the learning indicators that must be achieved by learners are then formulated.

d. Concept Analysis

Concept analysis is carried out to identify the concepts that will be taught later. This phase is carried out by analyzing the main concepts in Sel Electrochemistry material to produce a concept map.

e. Learning Objective Analysis

The formulation of learning objectives is intended to summarize the concept analysis and task analysis to determine the behavior of the research object. The learning objectives that have been

formulated in Sel Electrochemistry material are through the integrated STEAM-PjBL learning model by extracting information from various learning sources, conducting simple research and processing information, it is expected that students will be actively involved during the teaching and learning process. the process that occurs in analyzing Sel Electrochemistry material. Having a curiosity, being careful in observing and being responsible in expressing opinions, answering questions, giving suggestions and critiques, and being able to conclude the results of project-based learning data analysis on the material.

Design phase

This phase produces an initial design based on the define phase. The format for writing the initial draft of the integrated STEAM-PjBL LKPD is based on the guidebook for the development of teaching materials, which is the cover, supporting pages (foreword, table of contents, introduction to KPD, LKPD usage instructions, student identity), competencies to be achieved (KI, KD, IPK and Learning Objectives), tasks and work steps, and assessment. The LKPD is processed using Microsoft Word 2013.

Develop phase

This phase is an evaluation phase for the LKPD that has been designed through the validity and practicality test by experts. Each test is carried out with a revision phase based on the suggestions from each test conducted. a.

a) Validity Test

The determination of the validity of the integrated STEM-PjBL LKPD on Sel Electrochemistry material is carried out by 5 validators consisting of 3 chemistry lecturers from FMIPA UNP and 2 chemistry teachers at SMAN 6 Padang. The validation sheet contains 4 assessment aspects, namely the content feasibility component, language component, construction component (presentation), and graphic component (Depdiknas, 2008). a)

a. Content Feasibility Component Based on the assessed aspects, namely the LKPD content according to KD 3.4, 3.5, 3.6, 4.4, 4.5, 4.6 and IPK 3.4.1, 3.4.2, 3.5.1, 3.5.2, 3.6.1, 3.6.2, 4.4.1 , 4.5.1, 4.5.2, 4.6.1 and 4.6.2. In addition, the assessed aspect is the learning model used according to the material and LKPD content that can increase the knowledge of high school students. The average value of Aiken's V index is 0.947 with a very high level of validity.
b. Language Component
   The assessment of the language component of the developed LKPD has an average index of Aiken's V of 0.880 with very high validity. The assessment aspect of the language component according to Depdiknas (2008:28) includes: form and size of the readable font, clarity of information, conformity with good and correct Indonesian language rules, and the use of clear and non-confusing sentences.
c. Presentation Component
   Based on the assessed aspects, namely the LKPD that is designed according to the IPK and the order of presentation according to the IPK, as well as the presentation stages of the LKPD, an average index of Aiken's V of 0.900 was obtained with a valid category.
d. Graphic Component
   The assessment of the LKPD component was able to have a very high level of validity with an index of Aiken's V of 0.900. This shows that the size and type of font used are appropriate, the layout is appropriate, the placement of illustrations, images and graphics is appropriate, and the overall design of the worksheet is attractive.

a. Revision

This stage was carried out aiming to improve the STEM-PjBL integrated LKPD section on the Electrochemical Cell material which was considered inappropriate by the validator before the product was tested. This stage is considered complete if the developed LKPD is declared valid by the validator. So that the resulting LKPD is even better, which will then be tested.

b. Practicality Test

The practicality test of the STEAM-PjBL Integrated LKPD on Electrochemical Cell material was carried out to see the level of practicality of using the LKPD and the implementation of the developed LKPD. Assessment of the level of practicality of a teaching material can be seen in terms of ease of use, time efficiency and attractiveness of teaching materials to students' interests or in terms of their usefulness (Sukardi, 2012).

1. Ease of Use of LKPD

Based on teacher and student assessments of the ease of use of the developed LKPD, it is known that the STEAM-PjBL integrated LKPD on Electrochemical Cell material is very practical with a very high practicality category and the acquisition of NP scores is 98.4% (teachers) and 89.3% (students).). The NP value obtained indicates that the LKPD is delivered in a simple manner so that it is easily understood by teachers and students, clear learning steps in accordance with the Project Based Learning (PjBL) learning model.

2. Efficiency of Learning Time

The time efficiency component has an average NP value from the teacher's response questionnaire of 87.5% with a very high practicality category and a student response questionnaire of 89.7% with a very high practicality category. LKS in LKPD is intended to trigger and assist students in carrying out teaching and learning activities in order to master understanding, skills, and/or attitudes. In addition, the use of worksheets can help direct learning so that it is more effective and efficient (Majid. A and Rohman, 2014). Based on the NP value obtained, it shows that the developed LKPD has good efficiency in learning.

3. Benefits of using LKPD

The benefit component of using LKPD has an average NP value from the teacher's response questionnaire of 97.5% with a very high level of practicality and a student response questionnaire of 87.8% with a very high level of practicality. This states that LKPD provides benefits for teachers and students. One of the benefits for teachers is to increase the teacher's role as a facilitator. LKPD can help and assess student performance in groups and obtain information about student understanding through student activity in the learning process. The benefits obtained by students include increasing student interest which can help students compete in collaborating, communicating, increasing creativity, critical thinking skills and most importantly can help guide students in solving problems related to the material.

Based on the teacher's assessment, it was shown that the developed LKPD had an average NP value of 94% with a very high level of practicality.

No	Aspek yang Dinilai	%NP	Kategori Kepraktisan
1	Kemudahan Pengguanaan	98,4	Sangat praktis
2	Efisiensi waktu Pembelajaran	87,5	Sangat praktis
3	Manfaat	97,5	Sangat praktis
%NP dari semua komponen		94	Sangat praktis
%NP formula praktikalitas			

The results of the practicality test analysis by students obtained an average P value of 89% with an average analysis of each aspect as shown in the table.

No	Aspek yang Dinilai	%NP	Kategori Kepraktisan
1	Kemudahan Pengguanaan	89,3	Sangat praktis
2	Efisiensi waktu Pembelajaran	89,7	Sangat praktis
3	Manfaat	87,8	Sangat praktis
%NP dari semua komponen		89	Sangat praktis
%NP formula praktikalitas			

Based on the results of the practicality test that has been carried out, it is concluded that the integrated STEAM-PjBL (Science, Technology, Engineering, Art and Mathematic-Project Based Learning) LKPD integrated on the Electrochemical Cell material developed has fulfilled these three things. practicum component. namely ease of use, efficiency of learning time and benefits of use. The NP values obtained for the developed LKPD were 94% (for teacher practicality) in the very high category and 89% (for student practicality) in the very high category.

CONCLUSION

Based on the research that has been carried out, it is concluded that STEAM-PjBL (Science, Technology, Engineering, and Mathematic-Project Based Learning) integrated worksheets are produced on the Electrochemical Cell material using the 4-D development model. The resulting LKPD has the following validity and practicality criteria: (1) The validity level of the developed LKPD is obtained by the Aiken's V index of being in the very valid category; (2) The level of practicality by the teacher on the developed LKPD obtained an average NP value of 94% in the very practical category; and (3) the level of practicality by students on the developed LKPD obtained an average NP value of 89% in the very practical category.

DAFTAR PUSTAKA

Bender, William N.. 2012. Projec-Based Learning: Differentiating Instruction for the 21st century. Includes bibliographical references and index. ISBN 978-4129-4790-4.

Boslaugh, Sarah dan Paul A. W. 2008. Statistic In A Nutshell, A Desktop QuickReference. Beijing, Cambridge, Famham, Koln, Sebastopol, Taipei, Tokyo : O'reilly.

Depdiknas. 2008. Panduan Pengembangan Bahan Ajar. Jakarta : Direktorat Jendral Manajemen Pendidikan Dasar dan Menengah.

Majid, A., dan Rochman, C. 2014. Pendekatan Ilmiah dalam Implementasi Kurikulum 2013. Bandung: PT. Remaja Rosdakarya.

Nugroho,I, R, & Ruwanto, B. 2017. Pengembangan Media

Pembelajaran Fisika Berbasis Media Sosial Instagram Sebagai Sumber Belajar Mandiri Untuk Meningkatkan Motivasi Belajar Fisika Siswa Kelas XI SMA. Jurnal Pendidikan Fisika, 6(6), 460-470

Permendikbud, N. 36. (2018). Permendikbud Nomor 36. Tentang perubahan Permendikbud Nomor 59 Tahun 2014. jdih.kemendikbud.go.id

Purwanto. 2010. Evaluasi Hasil Belajar. Yogyakarta: Pustaka Pelajar. Sukardi. 2012. Evaluasi Pendidikan: Prinsip dan Operasional. Yogyakarta: Bumi Aksara.

Sugiyarti, L., Arif, A., & Jakarta, U. N. (2018). Pembelajaran abad 21 di sd. Prosiding Seminar dan DiskusiNasional Pendidikan Dasar, 439–444.

Thiagarajan, Sivasailam, Semmel, Dorothy, Semmel, Melvyn. 1974. Instructional Development for Training Teachers of Exceptional Children. Minneapolis: Indian University.

Yakman, G., Hyongyong, L. (2012). Exploring The Exemplary STEAM Education in the U.S. as a Practical Educational Framework for Korea. J Korea Assoc. Sci. Edu. Vol. 32, No. 6.

Yam,L.SH., dan Rosini,P. (2010).Effectiveness of ProjectBased Learning as a Strategy for Property Education.16(3), 291-313.