

## Development of a Phenomenon-Based Learning E-Worksheet Using Liveworksheets on the Topic of Chemical Equilibrium

Aulia Zahro Ramadhoni<sup>1\*</sup>, Herdini<sup>2</sup>, Lenny Anwar<sup>3</sup>

<sup>1,2,3</sup> Universitas Riau, Indonesia

### ABSTRACT

This study aimed to develop a Phenomenon-Based Learning (PhBL) electronic student worksheet (E-LKPD) on chemical equilibrium using Liveworksheets. The research employed a Research and Development (R&D) approach with the 4D development model (Define, Design, Development, and Disseminate). The study was conducted at SMAN 7 Pekanbaru and SMAN 9 Pekanbaru. Participants included three expert validators, two chemistry teachers, and 20 twelfth-grade students. Material validation results for content feasibility, PhBL characteristics, language feasibility, presentation feasibility, and graphical design were 95%, 97.22%, 91.67%, 95.83%, and 91.67%, respectively, indicating that the product was valid. Media validation results for display feasibility and software utilization were both 100%, and both were categorized as valid. Teacher responses reached 91.07% (very good), and student responses reached 87.31% (very good). Overall, these findings indicate that the developed PhBL-based E-LKPD for chemical equilibrium, using Liveworksheets, is valid and practical for classroom use.

Keywords: E-LKPD, chemical equilibrium, Liveworksheets, Phenomenon-Based Learning.

Received: June, 11 2025;  
Revised: August, 29 2025;  
Accepted: September, 10 2025

\* Corresponding author: [aulia.zahro1965@student.unri.ac.id](mailto:aulia.zahro1965@student.unri.ac.id)  
DOI: <https://doi.org/10.22437/jisic.v17i2.50405>

### INTRODUCTION

Education is one of the most important aspects in shaping high-quality human resources and future generations. However, students' low engagement during the learning process remains a common problem in education, often driven by the limited availability of teaching materials that effectively facilitate student learning. Teachers are therefore expected to address students' learning difficulties by selecting and developing appropriate instructional materials. One widely used resource is the

printed student worksheet (LKPD), which requires considerable cost and is relatively inefficient for learning. Beyond being costly, printed LKPDs can make learning feel monotonous and less engaging; as a result, students may become bored, overly dependent on teachers, and find it difficult to understand the material independently (Safitri et al., 2024).

Along with rapid technological transformation that has influenced education, technology has been utilized to



develop electronic student worksheets (E-LKPD). E-LKPDs can incorporate images, videos, and animations, and they enable students to access learning materials anytime and anywhere. E-LKPDs can also increase student engagement and motivation in learning, particularly for chemical equilibrium. In addition, E-LKPDs can support more effective learning by reducing space and time constraints (Suryaningsih & Nurlita, 2021).

Based on a preliminary study conducted with chemistry teachers at SMAN 7 Pekanbaru and SMAN 9 Pekanbaru, it was found that the currently used worksheets are not based on a model that connects chemistry content to real-life phenomena and do not integrate technology. Consequently, students have not met the school's Minimum Learning Objective Achievement Criteria (KKTP), which is 80. The mastery rates on chemical equilibrium tests at SMAN 7 Pekanbaru and SMAN 9 Pekanbaru were 40% and 45%, respectively. Therefore, an update is needed through the development of an E-LKPD that applies an instructional model and integrates it with technology.

Chemistry is relatively complex for students to master, requiring them to memorize, understand, analyze, apply, and use concepts in everyday life. Chemical equilibrium, in particular, is a highly complex phenomenon and is often perceived as difficult. This is because chemical equilibrium refers to changes in equilibrium states at the microscopic (molecular) level, which cannot be directly observed with the naked eye (Zahro' & Ismono, 2021). Moreover, chemical equilibrium requires students to have mathematical skills and a strong conceptual understanding, highlighting the need for a learning approach that links these concepts to everyday phenomena.

A learning model that connects chemistry content to real-life phenomena is Phenomenon-Based Learning (PhBL). PhBL provides students with opportunities

to discover academic concepts through real-world contexts (Maisarmah, 2021). This is supported by findings from Adriana et al. (2025), which show that implementing PhBL can foster students' enthusiasm and motivation during learning and improve their conceptual understanding. This approach is well suited to chemical equilibrium, which is abstract and difficult to understand, by representing it through observable phenomena in everyday life. The syntax of this model includes orienting students to a real phenomenon, organizing students for learning, guiding individual/group investigations, guiding students to present investigation results, and guiding students to analyze and evaluate the phenomenon (Elisa, E. et al., 2024; Symeonidis & Schwarz, 2016).

A technology platform that can be integrated into E-LKPD development is Liveworksheets. Liveworksheets is software that enables teachers to transform worksheets that would otherwise need to be printed into interactive, easily accessible electronic worksheets. Liveworksheets can be accessed by teachers and students on various devices without constraints on space or time (Daud, 2024). In addition, students can complete worksheets online, and teachers can review and assess students' responses directly. This application is advantageous for students because it is interactive and motivating; for teachers, it saves time; and it also reduces paper use (Firtsianta & Khofifah, 2022).

This is consistent with the study by Ismah et al. (2025), titled "Development of a Phenomenon-Based Learning E-LKPD Using iSpring Suite on the Topic of Hydrocarbons for Grade XI SMA/MA or Equivalent," which reported average validation scores of 91.562% (content experts) and 100% (media experts), categorized as very valid. Tryout results were also positive, with average scores of 89.7% from teachers and 86.5% from students, both categorized as very good.

## METHODS

This study will be conducted in the Chemistry Education Study Program, Faculty of Teacher Training and Education (FKIP), Universitas Riau, while the limited trial will be carried out at SMAN 7 Pekanbaru and SMAN 9 Pekanbaru. The research will take place from August 2025 to October 2025. The research instruments include a content/material validation sheet, a

media validation sheet, a teacher response questionnaire, and a student response questionnaire. This study employs a Research and Development (R&D) approach using the 4-D development model. The development process follows the 4-D model's 4 stages: Define, Design, Develop, and Disseminate. However, this study is limited to the development stage.

## RESULTS AND DISCUSSION

This study produced a Phenomenon-Based Learning (PhBL)-based electronic student worksheet (E-LKPD) using Liveworksheets on the topic of chemical equilibrium for Grade XI SMA/MA or equivalent. The study employed a Research and Development (R&D) approach using the 4-D development model (Define, Design, Develop, Disseminate). This research was conducted only up to the development stage; once the product was declared valid by expert validators, it was followed by a tryout.

### Define Stage

The Define stage consisted of three steps: front-end analysis, learner analysis, and task analysis. The front-end analysis was conducted to identify existing problems and to ensure that the developed product aligned with instructional needs. Interviews with chemistry teachers at SMAN 7 Pekanbaru and SMAN 9 Pekanbaru indicated that students' participation and learning motivation—particularly in understanding chemical equilibrium—remained low, contributing to students not meeting the school's Minimum Learning Objective Achievement Criteria (KKTP) for the chemical equilibrium topic.

The learner analysis showed that Grade XI SMA/MA students are typically 16–17 years old and belong to Generation Z. According to Yunita (2024), Generation Z is the first generation to grow up in the digital era and is closely connected to technology in everyday life. Moreover, Generation Z tends to benefit from an audiovisual learning style

that integrates visuals and sound to support understanding and increase engagement in the learning process (Urba et al., 2024).

The task analysis produced several components: (1) content-structure analysis (chemical equilibrium content aligned with the Merdeka Curriculum's Learning Outcomes/CP and Teaching Module Flow/ATP), (2) concept analysis (chemical equilibrium concepts organized in a concept map), (3) procedural analysis (following the PhBL syntax), and (4) goal analysis (learning objectives formulated based on the content-structure analysis).

### Design Stage

In the Design stage, the E-LKPD product was drafted to reflect PhBL characteristics and to meet feasibility criteria. The initial E-LKPD design was developed using several supporting tools: Canva (for design), PDF format (as a temporary file), and Liveworksheets (as the electronic worksheet platform). The developed E-LKPD included the following structure: the E-LKPD title, learning instructions, learning objectives, work procedures (aligned with the PhBL syntax), and practice questions (evaluation).

The E-LKPD title represents the topic presented in the worksheet's identity section. The E-LKPD title is shown in Table 1.

**Table 1.** E-LKPD Titles

Meeting	E-LKPD Title
1	Chemical Equilibrium Concepts
2	Concentration Equilibrium Constant ( $K_c$ ), Gas Equilibrium Constant ( $K_p$ ), and Degree of Dissociation
3	Factors Affecting Equilibrium Shift and Their Applications in Industry

The research instruments consisted of a content/material validation sheet (covering content feasibility, PhBL learning model characteristics, language feasibility, presentation feasibility, and graphical design), a media validation sheet (covering display and software utilization), a teacher response questionnaire, and a student response questionnaire.

### Develop Stage

The Develop stage produced the instructional material in the form of a PhBL-based E-LKPD using Liveworksheets on the

topic of chemical equilibrium for Grade XI SMA/MA or equivalent. This stage included product feasibility testing/validation, revisions based on validators' feedback, and product tryouts. Product validation included content and media expert validation, each conducted in two rounds.

Revisions to the E-LKPD were made based on comments, suggestions, and required improvements from each validation round until a valid E-LKPD was obtained. Revisions in the content/material aspect included adding example problems to Worksheet 2, enriching the brief material in Phase 2, adding news articles related to the phenomena, reorganizing unclear sentences, replacing nonstandard words, correcting typographical errors to comply with Indonesian writing conventions (PUEBI), and adding short biographies of chemistry figures. Revisions to the media aspect included adjusting image placement on the main cover, creating a main/home page for the E-LKPD, and relocating the user instructions and learning outcomes (CP) to the E-LKPD main page.

**Table 2.** Summary of Content Expert Validation

Assessment Aspect	Validation I (%)	Validation II (%)
Content Feasibility	75	95
PhBL Characteristics	69.45	97.22
Language Feasibility	66.66	91.67
Presentation Feasibility	75	95.83
Graphical Design Feasibility	50	91.67
<b>Average Score (%)</b>	<b>67.22</b>	<b>94.28</b>

**Table 3.** Summary of Media Expert Validation

Assessment Aspect	Validation I (%)	Validation II (%)
Display Feasibility	63.89	100
Software Utilization Characteristics	100	100
<b>Average Score (%)</b>	<b>81.95</b>	<b>100</b>

Table 2 presents the percentage summary of content expert validation, while Table 3 presents the percentage summary of media expert validation. Based on the results of both content and media validation, the developed product was classified as valid

and could therefore proceed to the tryout stage.

Next, a one-to-one trial, a teacher response evaluation, and a student response evaluation were conducted. The one-to-one trial involved three twelfth-grade students

from SMAN 9 Pekanbaru with different ability levels. The students' mean score was 89.1, and the average completion time was 63.11 minutes. However, the one-to-one trial indicated that the allocated time was excessive; therefore, the time allocation for

each E-LKPD needed to be adjusted. Appropriate time allocation should optimize learning time and enable efficient implementation of instructional activities (JK et al., 2021).

**Table 4.** Completion Time

Student Code (PD)	E-LKPD 1 (min)	E-LKPD 2 (min)	E-LKPD 3 (min)	Average (min)
PD-01	50	57	70	59
PD-02	53	60	73	62
PD-03	60	65	80	68.33
<b>Average</b>	<b>54.33</b>	<b>60.67</b>	<b>74.33</b>	<b>63.11</b>

**Table 5.** Student Scores

Student Code (PD)	E-LKPD 1	E-LKPD 2	E-LKPD 3	Average
PD-01	95	96	93	94.67
PD-02	90	88	90	89.3
PD-03	84	80	86	83.3
<b>Average</b>	<b>89.67</b>	<b>88</b>	<b>89.67</b>	<b>89.1</b>

**Table 6.** Summary of E-LKPD Time Allocation

E-LKPD	Initial Planned Time (min)	Mean Time Used (min)	Revised Time Allocation (min)
1	75	54.33	60
2	75	60.67	65
3	90	74.33	80

After the one-to-one trial with the three students, the study proceeded with a student-response evaluation involving 20 twelfth-grade students—10 from SMAN 7 Pekanbaru and 10 from SMAN 9 Pekanbaru. Based on the student response questionnaire, the student response score was 87.31%, which falls into the very good category.

The teacher response evaluation involved two teachers: one chemistry teacher from SMAN 7 Pekanbaru and one from SMAN 9 Pekanbaru. The teacher response score was 91.07%, also categorized as very good.

## CONCLUSION

The development of a PhBL-based E-LKPD on chemical equilibrium for Grade XI SMA/MA or equivalent was validated by both content and media experts. User

evaluations (from teachers and students) of the PhBL-based E-LKPD were very positive.

## REFERENCES

- Adriana, Y., Copriady, J., & Erviyenni, E. 2025. Penerapan Model *Phenomenon Based Learning* untuk Meningkatkan Pemahaman Konsep Peserta Didik pada Materi Termokimia di Kelas XI SMAN 15 Pekanbaru. *Cendikia: Jurnal Pendidikan dan Pengajaran*, 3(1), 81–89.
- Daud, D. 2024. “Pengembangan E-LKPD Interaktif Berorientasi SETS dengan *Liveworksheets* untuk Meningkatkan Minat dan Hasil Belajar Siswa”. *Media Bina Ilmiah*, 18(9), 2377-2392.
- Elisa, E, Wiratmaja, I.G., Mardhotillah, B., 2024. Enhancing the Understanding of Fundamental Concepts in Chemical Engineering Through Educational Adventure Games. *Journal of The Indonesian Society of Integrated Chemistry*, 16(2), 129-135.
- Firtsanianta, H., dan Khofifah, I. 2022. “Efektivitas E-LKPD berbantuan *Liveworksheets* untuk Meningkatkan Hasil Belajar Peserta Didik”. *Prosiding Conference of Elementary Studies*. 12 September 2022. FKIP UMS. Surabaya.
- Ismah, Haryati, S. & Anwar, S. 2025. Pengembangan E-LKPD Berbasis *Phenomenon Based Learning* menggunakan Ispring Suite pada Pokok Bahasan Hidrokarbon untuk Kelas XI SMA/MA Sederajat. *Scientica: Jurnal Ilmiah Sains Dan Teknologi*, 3(4), 168–175.
- JK, A. K. R., & Yuliani, Y. 2021. Pengembangan Lembar Kerja Peserta Didik Elektronik (E-LKPD) Berbasis Inkuiri pada Submateri Fotosintesis untuk Meningkatkan Kemampuan Argumentasi Peserta Didik. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, 10(3), 663-673.
- Maisarmah, S. 2021. Pengembangan E-Modul Pembelajaran Kimia Berbasis *Phenomenon Based Learning* untuk Mengarahkan Keterampilan Berpikir Kritis Siswa”. *Jurnal Pendidikan Kimia Universitas Riau*, 7(1), 42-54.
- Safitri, R., Syafril, Zuwirna, dan Supendra, D. 2024. Pengembangan Lembar Kerja Peserta Didik Elektronik (E-LKPD) pada Mata Pelajaran Informatika Kelas VII SMP. *Jurnal Pendidikan Tambusai*, 8(1), 11188–11192.
- Suryaningsih, S., dan Nurlita, R. 2021. Pentingnya lembar Kerja Peserta Didik Elektronik (E-LKPD) Inovatif dalam Proses Pembelajaran Abad 21. *Jurnal Pendidikan Indonesia*, 2(7), 1256–1268.
- Symeonidis, V. dan Schwarz, J. F. 2016. *Phenomenon-Based Teaching and Learning through the Pedagogical Lenses of Phenomenology: The Recent Curriculum Reform in Finland*. *Forum Oświatowe*, 28(2), 31–47.
- Urba, M., Ramadhani, A., Afriani, A. P., & Suryanda, A. 2024. Generasi Z: Apa Gaya Belajar yang Ideal di Era Serba Digital?. *DIAJAR: Jurnal Pendidikan Dan Pembelajaran*, 3(1), 50-56.
- Yunita, M. M. 2024. *Kebiasaan Belajar Generasi Z: Implikasi Psikologis dari Pendidikan Berbasis Teknologi*.
- Zahro', S. F., dan Ismono, I. 2021. Analisis Kemampuan Multirepresentasi Siswa Pada Materi Keseimbangan Kimia di Masa Pandemi Covid-19. *Chemistry Education Practice*, 4(1), 30.