



Received : 26 June 2025
Revised : 22 October 2025
Accepted : 25 October 2025
Published : 31 October 2025
Page : 319 – 331

Development of E-LKPD Project Based Learning Using Liveworksheet Integrated with Creative Thinking Skills

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Abstract: Reaction rate material involves both realistic and abstract concepts that require visualization and experimentation to better understand the influencing factors. Therefore, the use of a Project-Based Learning (PjBL) model is essential to connect theoretical knowledge with real-world contexts, enabling the creation of innovative and effective learning products that foster students' creative thinking skills. This study aims to develop an e-LKPD using Liveworksheets based on PjBL for reaction rate material and to evaluate its effect on students' creative thinking. The research employs the Lee and Owens Research and Development model using interviews, questionnaires, and pre-test–post-test instruments. Validation results from material and media experts indicate a high level of feasibility, while teacher assessments and student responses show strong satisfaction. The pre-test and post-test results reveal a significant improvement in creative thinking skills, with an N-Gain score of 0.6502. Overall, the developed e-LKPD is conceptually valid, practically applicable, and effective in enhancing creative thinking in chemistry learning, particularly in understanding reaction rate concepts.

Keywords: E-LKPD; liveworksheet, reaction rate; project based learning; creative thinking

INTRODUCTION

The development of science and technology in the era of the 4.0 revolution in the 21st century is increasingly rapid and creates challenges in several sectors, especially the education sector. Education is one of the efforts to master skills or thinking abilities in order to face the competition of the 4.0 industrial revolution era in the 21st century (Nasrullah et al., 2025). This 21st century education requires students to have complex knowledge equipped with skills called 4C skills which include critical thinking skills, creativity, collaboration, and

communication (Prabawati et al., 2023). So the Independent Learning Curriculum is here as an answer to the tight global competition in the 21st century.

Current learning implements the Independent Curriculum, the Independent Curriculum is a curriculum that supports the idea of independent learning, namely providing flexibility and independence to students and schools so that students can better explore their unique interests and skills according to student needs (Purnawanto, 2022). Learning in the era of independent learning involves independent conditions in

meeting the objectives, methods, materials and evaluation of learning for both teachers and students (Indarta et al., 2022). The Independent Curriculum also encourages students to develop critical, creative, and innovative abilities in thinking and acting in order to develop the creativity and character of students in schools.

Chemistry is one of the branches of science that is a compulsory subject in Senior High School (SMA). The chemistry subject taught at the senior high school (SMA) level is not only to transfer knowledge from teachers to students, but students are also expected to be able to develop students' creative thinking skills so that the knowledge they have can be applied to real life situations. According to Rambe (2024) chemistry is often considered a difficult subject and students do not want to study it further. This is because there are still many students who have difficulty understanding chemical concepts. One of the materials in chemistry learning is the reaction rate material in high school, especially in Phase F of class XI. According to Minarni et al. (2023) the reaction rate material has a realistic and abstract character, the occurrence of chemical reactions can be measured as slow or fast reactions, this is due to several factors including temperature, surface area of the material, concentration and catalysts. The chemical characteristics of the reaction rate need to be visualized and experiments carried out to more clearly describe the events and factors that influence the reaction rate.

In studying chemistry material, it cannot only be done by memorizing the concepts, but in the learning process, the creative thinking skills of the students themselves are also required. According to Rambe, (2024) creative thinking skills are a process of thinking to reveal new relationships, see things from a new perspective, and form new combinations of two or more concepts that have been mastered previously. According to Desmarani et al. (2021) the creative thinking skills process involves several elements such as fluency,

flexibility, originality, and elaboration. In order to develop students' creative thinking, a learning model is needed that is appropriate to class conditions and is student-centered, so that students become more interested in following the learning process.

According to the results of a preliminary study obtained from interviews with chemistry teachers at MAN 3 Jambi City, that current learning implements the Independent Curriculum. It is also said that students' interest in learning chemistry, especially in the material on reaction rates, is still relatively low, because it is difficult for students to understand the abstract material on reaction rates. This has resulted in a decrease in students' interest in following the learning process well, actively, and creatively. In addition, students' creative thinking skills are still relatively low, as seen from the small number of students who express their opinions (flexible indicator) and the lack of students in analyzing existing problems (fluent thinking indicator). Therefore, there needs to be chemistry learning based on Project Based Learning (PjBL) integrated with creative thinking skills because it is considered effective in increasing students' creativity so that students can explore concepts or science that makes their understanding better.

This is reinforced by research conducted by Nana Misrochah (2021) where students' creativity test scores increased with a good category so that PjBL-based learning is considered capable of increasing students' creativity. This is also in line with research conducted by Muhammad et al. (2022) that the project-based learning model has a significant influence on creative thinking skills and student learning outcomes. The teacher also said that the school had implemented E-LKPD but had never developed E-LKPD using liveworksheets based on PjBL integrated with creative thinking skills. The method used by the teacher in the chemistry learning process is the lecture method. The teaching materials used by the teacher are in the form of textbooks or printed books, LKS, Ministry of Education

and Culture modules and PowerPoint, but in its implementation, students do not have any interest and seem less active in the learning process. From the problems that have been explained, researchers are supported to use E-LKPD as a learning tool that can support the learning process so that students are more active and provide opportunities for students to develop creative thinking skills, so that learning is centered on students. E-LKPD is a digital learning tool as an exercise that can be easily accessed via PC/laptop or smartphone, E-LKPD data can be supported by images and videos of oral questions and can be answered at that time (Lioba et al., 2021). Good E-LKPD should be adjusted to the needs of students so that it needs to be combined with a learning model that suits the needs of students.

The selection of learning models must be directed at learning that leads to student creativity. In the Independent Curriculum, the use of the PjBL model is a recommended learning model because it can make students actively and creatively involved in the learning process. PjBL is a learning model that requires teachers to design learning with the final result of creating a real project, by giving assignments based on a problem in the initial stage, so that students can explore new knowledge and apply it in real life (Azizah & Purba, 2025). The PjBL learning model is suitable for application to reaction rate material because it can help students not only understand the concept of chemical reaction rates in more depth, but is also able to develop student collaboration so that it becomes an effective solution in improving students' cognitive and psychomotor abilities. This is in accordance with research by Rizki et al. (2021), stating that the PjBL learning model can make students develop in terms of their cognitive, affective, and psychomotor, students can solve problems on their own with a good level of thinking so that they can improve understanding of the material.

In developing E-LKPD based on PjBL integrated with creative thinking skills, researchers use liveworksheets that bridge

teaching and learning activities so that effective interactions will be formed between students and teachers. This platform allows teachers to change printable worksheets (documents, pdf, jpg, or PNG) into interactive online exercises that are also automatically corrected. Students can work on worksheets online and send their answers to teachers online. The advantages of this application are good for students because it is interactive and motivating, while for teachers this application saves time and also saves paper (Firtsanianta & Khofifah, 2022). Based on research conducted by Andini et al. (2022) shows that the development of E-LKPD can be used to train students' creative thinking skills and provide good results and is worthy of being applied to the learning process.

This is in line with research conducted by Mubarrok & Wahyuni (2023) the results of the study showed that E-LKPD assisted by liveworksheets is very feasible, very practical, and very effective in improving students' creative thinking skills.

Based on the development of learning tools that have been carried Mubarrok & Wahyuni, Firtsanianta & Khofifah and Andini, in this research will be carried out the development of E-LKPD based on PjBL using liveworksheets on reaction rate material integrated with creative thinking skills, determine conceptual and procedural feasibility based on the validity of material and media experts and determine the effectiveness of E-LKPD on creative thinking skills.

Based on the background above, researchers will conduct research entitled "Development of E-LKPD PjBL Using Liveworksheet Integrated with Creative Thinking Skills"

LITERATURE REVIEW

The advancement of information and communication technology has significantly influenced the educational landscape, particularly through the integration of electronic student worksheets (E-LKPD). E-LKPDs serve as digital learning tools that

provide students with access to materials, exercises, and assignments via electronic platforms. These worksheets incorporate interactive elements aimed at enhancing student engagement and improving cognitive, affective, and psychomotor domains (Kurniawan et al., 2024)

One popular platform for designing E-LKPDs is Liveworksheet. This platform allows educators to create digital, interactive worksheets with a variety of features, including drag-and-drop tasks, matching exercises, audio integration, and video support (Kurniawan et al., 2024). The key strengths of Liveworksheet lie in its user-friendliness, instant feedback system, and flexible accessibility. However, challenges such as internet dependency and varying device specifications can affect its optimal implementation.

The development of E-LKPD becomes even more impactful when integrated with the PjBL model. According to Simalango & Situmorang (2023), PjBL is a learning approach that emphasizes real-world problem solving and results in the creation of tangible products. Through hands-on and collaborative projects, students not only deepen their conceptual understanding but also enhance higher-order thinking skills, particularly creative thinking. The PjBL model consists of six key phases: fundamental questions, project design, scheduling, monitoring, evaluation, and reflection.

Integrating E-LKPD with PjBL contributes significantly to the enhancement of creative thinking skills, which are essential in 21st-century education. Rachmawati & Hidayah (2024) emphasize that creative thinking is a core competency in addressing global challenges. In accordance with Az-Zahra & Darmana (2024) principles of instructional media such as simplicity, integration, emphasis, balance, form, and color Liveworksheet-based E-LKPDs can be designed to be both visually appealing and pedagogically sound. An attractive and informative layout enhances

students' comprehension of subject matter while stimulating curiosity and creativity during project completion.

In summary, the development of E-LKPD using Liveworksheet based on PjBL and integrated with creative thinking skills presents an innovative solution in modern education (Siregar et al., 2024). This approach not only facilitates accessible and engaging learning but also equips students with essential higher-order thinking skills that are vital in meeting the demands of the 21st century.

METHODS

This type of research is research and development (Research and Development). The model used in this development is the model proposed by Lee & Owens. The reason for choosing this model is because this model is a model that is specifically designed to develop multimedia. This development model is said to be a procedural model because the sequence of steps in the process is arranged systematically and each development step has a clearly arranged sequence of development steps. The research and development procedure in the Lee & Owens (2004) model consists of five stages, as shown in the following picture:

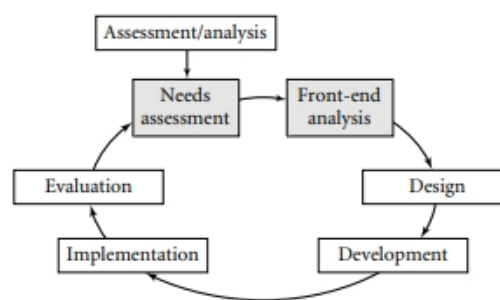


Figure 1. Development Model Lee & Owens (2004)

A systematic instructional design model often used in developing technology-based teaching materials. However, this research only covers the analysis, design, and development, implementation and evaluation stages (Nasrullah et al., 2025)

RESULT AND DISCUSSION

In this study, the results were obtained from each stage of the Lee & Owens (2004) development model which consists of five stages, namely: analysis, design, development, implementation and evaluation.

Analysis

At the analysis stage, a needs assessment was conducted to identify students' learning challenges related to the reaction rate topic. Data collected through student questionnaires and interviews with the chemistry teacher, Mrs. Halimatussa'diyah, S.Pd, revealed that 85.7% of students struggled to understand and learn reaction rate concepts. This finding aligns with Rachmawati & Hidayah (2024), who state that chemistry is often perceived as a difficult subject due to the abstract nature of its concepts. Most students admitted they had difficulty following the teacher's explanations, indicating the need for additional and more engaging learning materials. This aligns with the *Independent Curriculum*, which emphasizes the importance of adapting learning methods to students' needs and interests. However, teaching media at the school were still limited, relying mainly on printed textbooks. As confirmed by the teacher, digital and interactive learning tools were rarely used, even though such media can improve students' interest and motivation to learn.

An analysis of student characteristics further showed that 90.5% of students enjoyed learning chemistry using digital media, especially those involving smartphones. All respondents owned smartphones and could access online learning resources, and 85.7% expressed interest in using e-LKPDs based on Project-Based Learning (PjBL) via *Liveworksheets*. Teacher interviews also revealed that current teaching materials such as textbooks, Ministry of Education modules, and PowerPoint slides were insufficient to deepen students' understanding.

Material analysis was then carried out to align content with the learning objectives of the *Independent Curriculum* for Phase F (Grade XI) at MAN 3 Jambi City. At this phase, students are expected to master concepts such as chemical calculations, reaction energy, equilibrium, and reaction rates, as well as demonstrate critical thinking and creativity through scientific work. These goals align with strengthening the *Pancasila Student Profile*, which emphasizes being honest, critical, independent, and innovative.

Since the reaction rate topic is abstract and formula-heavy, it often causes difficulty for students. Therefore, implementing PjBL with ICT-based e-LKPDs can help students better grasp the concept by linking theory to real-life applications while developing creative thinking skills. The school's infrastructure also supports this innovation 100% of students have smartphones, 80.9% regularly use them for schoolwork, and the school is equipped with computers, projectors, and internet access. Thus, developing an ICT-based e-LKPD using *Liveworksheets* for the reaction rate topic is both feasible and beneficial.

In conclusion, students of Grade XI Phase F2 MAN 3 Jambi City require more engaging and interactive teaching media to enhance interest, motivation, and understanding of chemistry. Integrating PjBL into ICT-based e-LKPDs can effectively support conceptual understanding, connect chemistry to daily life, and foster students' creative thinking skills.

Design

At the design stage, researchers begin to design research starting from team formation, research schedule, media specifications used, material structure, making flowcharts and storyboards. Related materials and images that will be included in the product are also collected. In designing and designing products, researchers use the

theoretical basis of cognitive learning, behaviorism and constructivism.

The development of the e-LKPD using *Liveworksheets* integrated with PjBL is influenced by cognitive learning theory. According to Piaget, cognition involves mental activities related to perception, thinking, and information processing that enable individuals to acquire knowledge and solve problems (Satria & Egok, 2020). Applying cognitive principles in e-LKPD design focuses on how students process information, construct understanding, and develop thinking skills through active engagement. Therefore, the e-LKPD is designed with texts, images, and animations to support interactive learning, enhance information processing, and help students retain concepts in long-term memory

Furthermore, the influence of behaviorism theory in the development of e-LKPD uses liveworksheets based on PjBL as long as developers design and design flowcharts and storyboards which are part of the stimulus so that changes in student behavior occur. According to Ismail et al. (2019) behaviorism learning theory emphasizes its study on the formation of behavior based on the relationship between stimulus and observed response and does not connect with consciousness or mental construction. By making flowcharts and storyboards, overall there are main guidelines by researchers as a stimulus for students in developing product designs. In addition, behaviorism theory can also be integrated into the material. The material presented must be in accordance with the needs and characteristics of students in order to be able to create a good learning environment for students. the use of colors, images, animations, well-designed text will greatly influence someone in learning.

After that, the influence of constructivism theory in e-LKPD development using liveworksheet based on PjBL is integrated into the design of the learning process related to the project being

developed. In constructivism theory, it is not just memorizing but the process of constructing knowledge through experience. Knowledge is not the result of "giving" which will not be meaningful. As for knowledge obtained through the process of constructing knowledge by each individual, it will provide deeper meaning or be more mastered and stored/remembered by each individual for longer (Suyono & Hariyanto, 2014). In a simple project related to the material of factors that influence the reaction rate in e-LKPD, it is expected that students can actively experiment with the material of factors that influence the reaction rate to hone creative thinking skills and deepen understanding of the concept of reaction rate. With a simple project, it will help the development of student learning.

Development

After the design stage is carried out, the researcher then carries out the development stage based on the storyboard design that has been determined. The development of this e-LKPD uses a liveworksheet platform with a link format that can be accessed via smartphone, laptop or computer in the form of the link <https://bit.ly/e-LKPDLajuReaksi>. This product will later contain a cover page, instructions for use, learning achievements, learning objectives, materials, images and projects related to the reaction rate material. The initial product produced is then validated by a team of experts, namely materials and media to assess the feasibility of the product being developed. The results of this validation are used as material for product improvement, then the product is revised again according to the experts so that a valid product is obtained for testing. In developing this e-LKPD, validation was carried out by material experts 2 times and media experts also 2 times. In the validation process for the development product, several assessment aspects were used. The assessment aspects in the preparation of the material are curriculum, content, language and assessment. While in the assessment

aspect of the media used, namely relevance to the teaching module, layout, language, aesthetics and assessment.

Validation of the material was carried out by Mrs. Dr. Diah Riski Gusti, S.Si., M.Si obtained a total score of 48 with an average score of 3.2 in the interval >2.6 -3.4 with the category "quite feasible". Based on the validation of the material, the results showed that the reaction rate material was less in accordance with the learning objectives so it had to be improved. Furthermore, the material presented in the e-LKPD product needs to be added with a simple project in accordance with the reaction rate material so that improvements must be made. This is related to the suitability of the material to encourage the curiosity of these students. In addition, it is necessary to add another reaction rate project to match the achievements and learning objectives. In the first validation, it was concluded that the teaching material was suitable for use but needed to be revised according to the suggestions of the validator. The graph of the results of the first material expert validation is as follows:

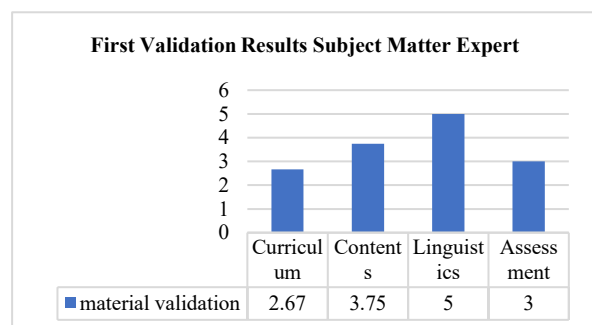


Figure 2. Instrument Result Graph Validation First Material Expert

Furthermore, revisions were made regarding suggestions for improvement by the second material expert, obtaining a total score of 70 with an average score of 4.67 in the interval >4.2 -5.0 in the category of "Very Eligible". All suggestions and improvements provided by the material expert in the results of the first stage of validation have been carried out and the material expert validator stated that the e-LKPD that was developed

was declared good and feasible to be tested in schools without improvements or revisions. The details of the results of the second material expert validation can be seen in the following graph:

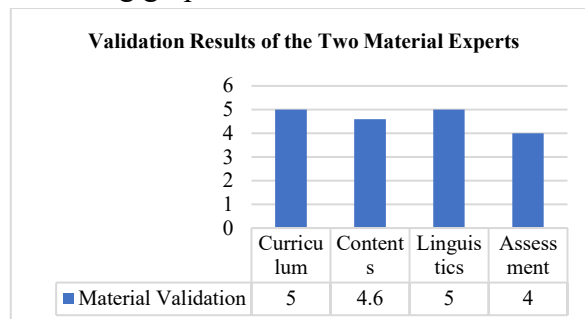


Figure 3. Instrument Result Graph Validation Both Material Expert

Based on the first and second validation, a total score diagram was obtained which is shown in the graph as follows:

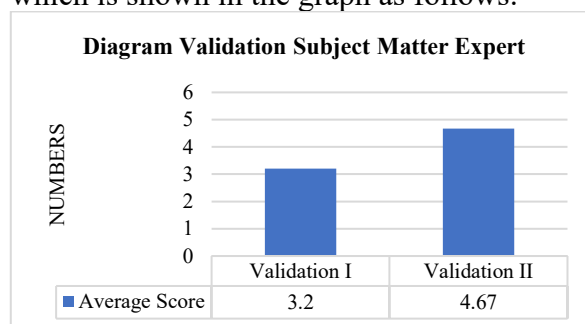


Figure 4. Diagram of Subject Matter Expert Scores for Stages I and II

Next, media validation was carried out by Mr. Dr. rer. nat. Asrial, M.Si obtained a total score of 49 with an average score of 4.21 in the interval >3.5 -4.2 in the "Feasible" category. There were several suggestions for improvement from media experts, namely improvements to the images, writing and animations on each page in the e-LKPD to match the reaction rate material. After that, on the suitability of the color combination and gradation on each page of the e-LKPD. Finally, the assessment is more adjusted to the learning objectives with the material to be used. Furthermore, these suggestions and improvements will be followed up to be instructions for making improvements to the e-LKPD. The results of the first stage of media expert validation obtained the results that the media developed was declared feasible to be tested in the field with revisions. The graph of

the results of the first media expert validation is as follows:

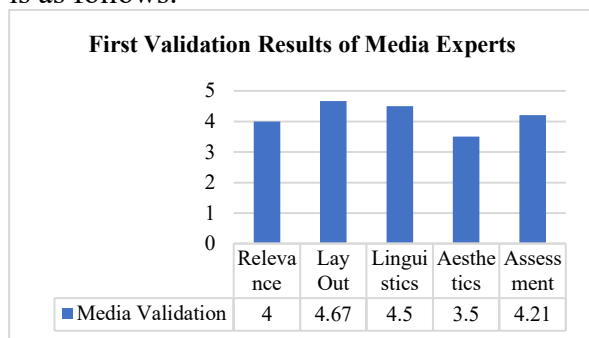


Figure 5. Instrument Result Graph Validation First Media Expert

Next, a revision was made regarding the suggestions for improvement by the second media expert, obtaining a total score of 69 with an average score of 4.92 in the interval $>4.2-5.0$ in the category of "Very feasible". All suggestions for improvement and comments given by the media expert on the results of the first stage of validation have been carried out, so that based on the scores and average scores obtained, the media expert validator stated that the teaching materials developed had met all aspects and demands of good and correct media or teaching materials and were feasible to be tested without improvement or revision. The graph of the results of the second media expert validation is as follows:

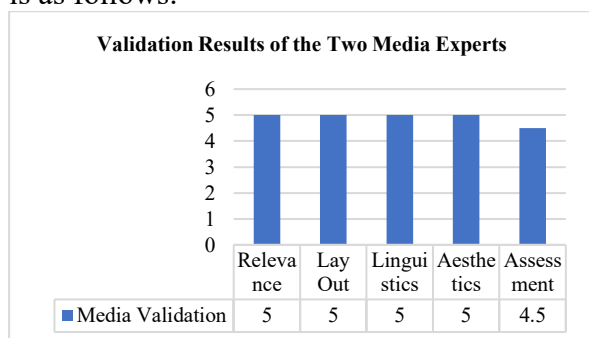


Figure 6. Instrument Result Graph Validation Both Media Expert

Based on the first and second validation, the total score diagram is obtained as shown in the image below:

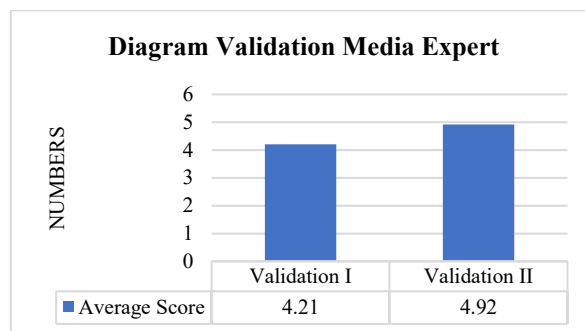


Figure 7. Stage I and II Media Expert Score Diagram

After the researcher carried out the development stage which ended with validation by experts, it was continued with the implementation stage. Before the e-LKPD product was given to students, a teacher assessment was carried out by Mrs. Halimatussa'diyah, S.Pd as the chemistry teacher for class XI phase F2. The results obtained were a total score of 82 with an average score of 4.82 and were in the interval $>4.2-5.0$ in the "Very Good" criteria. Based on this assessment, the teacher also provided general comments or suggestions, namely that the product developed was good and neat and in accordance with the material presented.

Implementation and Evaluation

At the implementation stage, a product trial was conducted in class XI phase F2 MAN 3 Kota Jambi. The trials conducted were one-on-one trials, small group trials and large group trials. It began with a one-on-one trial by 3 students of class XI phase F2 MAN 3 Kota Jambi with different levels of ability offline by providing the product that had been developed.

Based on the one-on-one trial, the average score for the one-on-one trial was 4.48 in the "Very Good" criteria. The highest assessment was obtained on the indicator of the reaction rate material explained that it can be applied in everyday life and providing motivation in learning with a percentage of 100%. While the lowest assessment was obtained on the indicator related to the usefulness of e-LKPD for independent learning, ease of use and access to e-LKPD with a percentage of 80%. So based on the average score that has been obtained, the e-LKPD liveworksheet product based on PjBL material on reaction rates integrated with

creative thinking skills is considered to be usable for all levels of student ability. Continued with a small group trial involving 15 students of class XI phase F2 MAN 3 Jambi City offline, the average score for the small group trial was 4.6 in the "Very Good" criteria. The highest assessment was obtained on the attractive media display indicator with a percentage of 98.67%. While the lowest assessment was obtained on the indicator related to the concept map on e-LKPD presented with a clear display with a percentage of 86.67%. Overall, students feel interested because the teaching materials have an attractive appearance so that they can increase motivation to learn chemistry and make it easier to understand the reaction rate material.

After the researchers conducted a small group trial, a large group trial was continued by involving the experimental class, namely class XI phase F2 MAN 3 Jambi City consisting of 35 students to see the effectiveness of the development of e-LKPD liveworksheet reaction rate material based on PjBL integrated with creative thinking skills. The results of this trial obtained an average score of 4.49 in the "Very Good" criteria. The highest assessment was obtained on the e-LKPD display indicator which makes learning more interesting with a percentage of 96.57%. While the lowest assessment was obtained on the indicator related to the suitability of the reaction rate material with the subject matter and the e-LKPD indicator is useful in helping to understand the concept of reaction rate more easily with a percentage of 85.71%. Overall, it can make it easier for students to learn independently, increase motivation and make it easier for students to understand the reaction rate material and be able to train students' creative thinking skills.

In the large group trial, a creative thinking evaluation was also carried out through a pre-test and post-test to measure students' creative thinking skills. The pre-test was conducted at the beginning of the learning process while the post-test was conducted at the end of the learning process with the same respondents, namely 35 students of class XI

phase F2 MAN 3 Kota Jambi. To measure the specific differences between the pre-test and post-test, a T-Paired test (paired test) is needed, but as a prerequisite for the T-Paired test, the researcher conducted a normality test to show that the sample data came from a normally distributed population. Conducted using the SPSS 25 program, the normality test with the Shapiro Wilk one-sample test (<100) obtained a significance value for the pre-test of 0.114 and for the post-test of 0.101. The results of this significance value indicate that the data is normally distributed where the significance value of each data is more than 0.05.

Continued T-Paired test using SPSS 25 program to determine the effectiveness of the use of e-LKPD liveworksheet products reaction rate material based on PjBL. Based on the T-Paired test, it can be seen that the t-count value obtained is 14.089 which when compared with the t-table value of 2.034 at a real level of 95% ($\alpha = 0.05$), then the t-count $>$ t-table is obtained. So if adjusted to the hypothesis, if the t-count $>$ t-table and the Sig value (2-tailed) < 0.05 then H_1 is accepted and H_0 is rejected. Based on these results, it can be concluded that there is a difference in the average between the pre-test and post-test learning outcomes, namely a significant influence on the use of e-LKPD liveworksheet reaction rate material based on PjBL integrated with creative thinking skills.

To support the T-Paired test which states that there is a significant influence on the use of e-LKPD using liveworksheets on the reaction rate material based on PjBL integrated with creative thinking skills, the researcher continued to conduct an N-Gain test to measure the increase in creative thinking skills and cognitive learning outcomes before (pre-test) and after (post-test) learning. The questions tested were in the form of essays and the assessments carried out had been adjusted to the creative thinking assessment rubric, so that an average increase in students' creative thinking skills was obtained as indicated by an N-Gain score of 0.6502 with a percentage score of 65.02% in the "moderate/quite effective" category. This

is in line with research conducted by Permatasari et al. (2023) that learning with the PjBL model can improve creative thinking skills. Also strengthened by research by Oktaviana et al. (2024) which stated that e-LKPD products using liveworksheets obtained validity with valid and practical categories for use. So that e-LKPD products using liveworksheets are considered capable of attracting and encouraging students to think creatively. As well as research conducted by Hamsar et al. (2024) that the application of PjBL in learning has proven effective in facilitating the improvement of students' creative thinking skills.

Based on the validation results of the material expert team, media experts, teacher assessments, student responses and relevant research related to the e-LKPD liveworksheet product based on PjBL integrated with creative thinking skills, it is concluded that the e-LKPD liveworksheet product based on PjBL is declared valid, practical, and effective can be used as teaching materials in learning and has the potential to improve creative thinking skills in order to maximize the achievement of learning objectives in the reaction rate material.

The development of an e-LKPD using the PjBL model integrated with the Liveworksheet platform has proven effective in enhancing students' learning motivation and creative thinking skills, particularly on the topic of reaction rates. This aligns with Jean Piaget's constructivist theory, which posits that knowledge is actively constructed by learners through direct experiences and exploration. Through PjBL, students are encouraged to build their own understanding especially as they engage in projects connected to real-life chemical phenomena.

Moreover, the use of interactive digital media such as Liveworksheet supports Bruner's cognitive theory, which emphasizes the importance of instructional media in facilitating the internalization of knowledge. The visually engaging design and clear, simple language of the e-LKPD help learners grasp the concept of reaction rates in stages,

consistent with their developmental thinking levels.

In terms of instructional design, the development of this e-LKPD follows the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). At the evaluation stage, validation results from experts and student feedback indicate that the product is categorized as "excellent" in terms of appearance, ease of use, and effectiveness in aiding conceptual understanding.

The evaluation of its effectiveness, based on the improvement from pre-test to post-test scores, demonstrates a statistically significant impact. This finding supports Thorndike's behaviorist theory, particularly the law of effect, which states that learning experiences producing positive outcomes will reinforce future learning behaviors. The e-LKPD provides immediate feedback, enabling students to monitor their learning progress in real-time, thereby enhancing intrinsic motivation.

Regarding the enhancement of creative thinking skills, this development is consistent with J.P. Guilford's theory of creativity, which identifies four key indicators: Originality, reflected in students' ability to generate unique project ideas. Fluency, fostered through repeated project-based exercises and problem-solving tasks. Flexibility, developed as students explore multiple strategies to complete their projects. Elaboration, evident in detailed, well-structured project reports.

The interactive nature of the e-LKPD featuring drag-and-drop activities, embedded videos, and instant feedback offers a user-friendly learning environment that aligns with the principles of digital instructional design as proposed by Az-Zahra & Darmana (2024), which emphasize simplicity, integration, balance, and visual appeal. This finding is further supported by Kurniawan et al., (2024). who highlight the significant role of E-LKPDs in improving not only cognitive outcomes but also affective and psychomotor domains through accessible digital learning tools.

The incorporation of the PjBL model within the e-LKPD structure also proves impactful in fostering higher-order thinking, particularly creative thinking, as evidenced by the increase in post-test scores and N-Gain value of 0.6502 in this study. This supports the claims of Simalango & Situmorang (2023), who argue that PjBL enhances students' ability to solve real-life problems by engaging them in hands-on projects. Furthermore, the observed improvement in creative thinking indicators originality, fluency, flexibility, and elaboration validates the framework put forth by Az-Zahra & Darmana (2024), which suggests that PjBL can develop essential 21st-century competencies through contextualized and student-centered tasks.

In line with Rachmawati & Hidayah (2024) who state that creative thinking is fundamental in responding to global challenges, this study confirms that integrating PjBL with digital platforms like Liveworksheet not only supports content mastery but also cultivates student creativity. Thus, the developed e-LKPD stands as an innovative and effective instructional tool that supports modern pedagogical needs, aligns with technological advancements, and promotes active, creative, and meaningful learning experiences.

CONCLUSION

The study concludes that the developed e-LKPD Liveworksheet based on PjBL for reaction rate material is effective and of very good quality. Designed with Canva and following Lee and Owens' design model, it was validated by experts and positively assessed by teachers and students. Trial results show that the e-LKPD is suitable for different student ability levels and successfully enhances creative thinking skills in learning reaction rates. Overall, this e-LKPD provides an interactive and effective teaching tool that supports creativity-oriented chemistry learning

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