



Interactive E-LKPD Based on CTL (Contextual Teaching Learning) Assisted Wizer.me to Train Students' Learning Independence in Hydrocarbons

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Abstract: This study aims to design an interactive Electronic Student Worksheet (e-LKPD) based on the Contextual Teaching and Learning (CTL) model, drawing reference from the Wizer.me website, to enhance students' autonomy in learning hydrocarbon materials. Hydrocarbon concepts are abstract and complex, requiring new approaches to learning. Computer-based learning media feature interactive components that support student participation and independence. This research employed the Research and Development (R&D) approach utilizing the ADDIE model (Analyze, Design, Develop, Implement, and Evaluate). The developed e-LKPD was validated with experts at an 88% validity level (very valid). Student response questionnaires yielded a practicality level of 95.83% (very practical), and the student learning independence percentage was 79.42% (practical/effective). The measure of effectiveness, as determined by the n-gain test, was 63.69% (fairly effective). These findings demonstrate that the interactive e-LKPD is a valid, feasible, and effective learning tool to support students' learning independence in hydrocarbon materials. This study contributes to the use of digital learning media in chemistry education, facilitating student-centered learning and active participation.

Keywords: hydrocarbon; independent curriculum; independent learning; interactive e-lkpd, wizer.me website

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INTRODUCTION

Chemistry education is one of the pillars for the development of scientific literacy, which includes the basic concepts of chemical bonding, reactions, and their practical applications, that instills in students a sense of self. However, due to its abstract and complex nature, chemical education can be quite challenging for students to comprehend (Johnstone, 2006; Taber, 2021). Hydrocarbons have generally been one of the most challenging topics, surrounded by many misconceptions, which makes it difficult for students to understand molecular structures and the mechanisms of their reactions (Chittleborough, 2014; Ghassani et al., 2023; Kurniawan & Hidayah, 2022). Studies revealed that conceptual misunderstandings of hydrocarbons come from students' inability to connect symbolic, macroscopic, and submicroscopic representations of chemical phenomena (Bergdahl & Bond, 2022; Johnstone, 2006; Taber, 2021). These conceits also remain active due to the lack of real-life applications, making it hard for students to visualize abstract hydrocarbon engagements (Fischer et al., 2018; Ryan & Deci, 2020; Schunk & Zimmerman, 2011). Therefore, it is essential to provide students with support through independent learning, enabling them to connect more effectively with abstract hydrocarbon concepts (Garrison & Vaughan, 2007; Pintrich, 2004). Self-regulated learning enables students to become aware of their contributions to the learning process, allowing them to form better conceptual relationships within chemistry (Chan & Pow, 2020; Fahmi & Fikroh, 2022; Mayer & Fiorella, 2021). Instructional strategies that should accompany effective independent learning include engaging, interactive, and technology-oriented teaching methods (Polontalo et al., 2023; Dasar et al., 2020; Suryandari et al., 2023). Furthermore, research also indicates that the integration of digital tools in chemistry education enhances students' capacity to visualize abstract concepts, thus alleviating misconceptions and yielding positive learning outcomes (Anderson, 2021; Gabel, 2019; Jonassen, 2021). Other studies have also demonstrated that teaching with multimedia enhances students' understanding and retention of hydrocarbon (Bransford, 2020; Kapur, 2021). Moreover, the infusion of real-world examples and the use of problem-based learning approaches can link theoretical learning with actual practice, making hydrocarbon chemistry more relatable and interesting to students (Afriyadi et al., 2023; Lin, 2022).

Independent learning is a self-regulated process in which goals for learning are set, progress toward those goals is monitored, and strategies are adjusted to achieve academic success (Andriani & Dwiningsih, 2024; Ryan & Deci, 2020). Independent learning skills, as demonstrated in chemistry, are considered a crucial part of

education and have a positive relationship with students' academic achievements (Bergdahl & Bond, 2022; Fahmi & Fikroh, 2022; Schunk & Zimmerman, 2011). The 2022 research evaluated the independence of chemistry students, showing levels of high (17.87 percent), medium 60.87% and low 21.74%, while the majority still failed to achieve the minimum learning achievement standard (KKTP) of 78 (Ghassani et al., 2023; Kementerian Pendidikan dan Kebudayaan Republik Indonesia, 2016; Yamin & Syahrir, 2020). Research highlights the importance of developing novel strategies to foster and encourage self-directed learning capabilities, thereby enhancing student performance (Garrison & Vaughan, 2007; Schunk & Zimmerman, 2011). Integrating innovative technology into learning activities appears promising not only for nurturing student engagement and motivation but also for enhancing independence in learning (Hwang et al., 2020; Mayer & Fiorella, 2021; Schmid, 2021). There is sufficient evidence that e-learning provides students with a format to increase their knowledge at a distinctive pace by reiterating viable principles along individual pathways, allowing them to widen their understanding (Laoli, 2021; Ryan & Deci, 2020). The incorporation of self-paced computerized tutorials with interactive features may serve as a tool to bridge the alleged gap that has existed in chemistry studies between theory and practical knowledge (Mayer & Fiorella, 2021; Yang et al., 2022). It can be asserted that independent learning strategies can be best supported by appropriate digital interventions, which help promote student outcomes (Bergdahl & Bond, 2022; Garrison & Vaughan, 2007; Pintrich, 2004). Accordingly, research confirmations in touch with e-LKPDs would aid in inducing a necessary apex of significant influence within the transition of self-regulated learning that intuitively aims for excellent performance (Lai & Gu, 2011). On the other hand, it has also been found that the application of digital tools haunts every determining space of encouraging independence and responsibility among students, which constitute the necessary attributes of independent learning (Darling-Hammond, 2017; Trilling, 2009; Voogt, 2008). In addition, adaptive learning technologies can provide feedback and support to help students identify their learning gaps (Brown et al., 2019; Hew & Lo, 2018; Nababan, 2023).

Digital learning media are now being invented and perfected to not only enhance the learning process of students but also improve the transfer of skills they have obtained to real-life situations (Fahmi & Fikroh, 2022; Mayer & Fiorella, 2021; Polontalo et al., 2023). School trends have taken over paper in school life, while computer technology has become a staple in ICT in daily life. It enables students to access a vast array of resources, assists in building knowledge, and teaches how to apply this knowledge later in life (Kementerian Pendidikan dan Kebudayaan Republik Indonesia, 2016; Schmid, 2021). Several studies have demonstrated that digital interactive learning platforms, including digital worksheets, educational games, and other multimedia forms, are generally associated with improved learning outcomes for students (Dasar et al., 2020; Yang et al., 2022). Generally, digital worksheets provide space and time for students to actively engage in a form of writing that is not traditionally practiced (Bergdahl & Bond, 2022; Garrison & Vaughan, 2007; Schunk & Zimmerman, 2011). Among the interactive e-LKPDs, digital worksheets often contain content accompanied by brief videos, simulations, or interactive assessment questions that can engage students (Polontalo et al., 2023; Dasar et al., 2020; Suryandari et al., 2023). Interactive e-LKPDs eliminate paper dependency during the learning process, thereby leading to sustainable education programs (Garrison & Vaughan, 2007; Yang et al., 2022). In general, they are easy to access at any time and from anywhere; thus, the entire education process becomes more affordable and efficient (Ryan & Deci, 2020; Schmid, 2021; Yamin & Syahrir, 2020). Students may receive numerous advantages from the provision of digital worksheets, including quick and precise analysis-aiding time management for teachers when they intervene to make changes (Hasudungan, 2022; Laoli, 2021; Ansori & Herdman, 2019). Modern e-LKPD digital applications are also being used to promote cooperative learning by facilitating discussions among students and assisting them through problem-solving, thereby enabling an advancement in their understanding levels. Several studies have demonstrated to students the connection between the goal and the activity that bright gamification aspects in e-LKPDs facilitate (Anderson, 2021; Hew & Lo, 2018; Jonassen, 2021). Moreover, when the blend of activities includes Wizer.me, a platform designed for student use, a significantly greater interest in learning with technology is expected. The activity with hydrocarbons comes alive and vividly through simulations and real-life situations that engage students to perform (Ramadhani, 2024; Usman, 2023; Wilson, 2022).

The development of the interactive e-LKPD can be aided by Wizer.me, a platform that offers numerous digital tools for designing engaging learning activities (Ramadhani, 2024; Schmid, 2021). This platform enables educators to incorporate images, videos, essay questions, multiple-choice tests, and interactive mini-games, thereby facilitating a student-centered learning process (Bergdahl & Bond, 2022; Garrison & Vaughan, 2007; Yamin & Syahrir, 2020). The user-friendly interface allows teachers to customize learning materials according to their students' needs and interests (Dasar et al., 2020; Yang et al., 2022). Several studies have investigated the application of Wizer.me in digital learning; however, few have explored its interactive potential based on hydrocarbons (Laoli, 2021; Polontalo et al., 2023; Suryandari et al., 2023). Most existing research has focused on digital learning strategies in general, rather than specific applications in classroom settings (Bergdahl & Bond, 2022; Mayer & Fiorella, 2021; Yang et al., 2022). Through the use of Wizer.me as an interactive e-LKPD tool,

students are more actively engaged in exploring hydrocarbons through multimedia integration (Schmid, 2021). Therefore, this research will develop an e-LKPD for hydrocarbons that will also be interactive, within the framework of the independent curriculum, by utilizing Wizer.me features that enhance student independence and engagement in the learning process (Hasudungan, 2022; Laoli, 2021; Ansori & Herdman, 2019). In addition, the principles of contextual teaching and learning (CTL), which relate to connecting classroom content with real-world experiences, provide a framework for enhancing learning courses in chemistry through the interweaving of Wizer.me (Hasudungan, 2022; Laoli, 2021). More recent studies have also emphasized the capability of Wizer.me in enhancing higher-order thinking skills, such as critical thinking and problem-solving, as well as the mastery of complex subjects like hydrocarbons (Nababan, 2023; Usman, 2023; Wilson, 2022). Therefore, we can confidently state that this is a highly effective tool that greatly assists us. In addition to the immediate feedback this tool provides, it offers personalized learning, simplifying individualized instruction in self-directed learning (Bembenutty, 2020; Winne, 2021).

The research questions in this study include the following: 1) In what manner does the interactive e-LKPD for hydrocarbons meet the validation criteria? 2) To what extent does e-LKPD meet the practical requirements? 3) How effective is the interactive e-LKPD for hydrocarbons? The research aims to investigate the validity, practicality, and effectiveness of an interactive e-LKPD based on Wizer.me in improving independent learning for students studying hydrocarbon chemistry. The research is conducting these tasks to further the understanding of the use of digital tools in chemistry education, specifically in cases that promote self-directed learning and address misconceptions in hydrocarbon chemistry (Kapur, 2021; Usman, 2023; Wilson, 2022). The study is also situated within a global trend of increasing emphasis on integrating technology in education, contributing to the improvement of the educational process and helping students develop 21st-century skills (OECD, 2022; Trilling, 2009; Voogt, 2008). This research is expected to provide valuable guidance to teachers and policymakers in developing effective digital learning strategies for chemistry education (Darling-Hammond, 2017; Afriyadi et al., 2023).

METHODS

Research and Development (R&D) is the focus of this type of study. The ADDIE model, which comprises the phases of Analysis, Design, Development, Implementation, and Evaluation, is utilized in this research and development process (Syahid et al., 2024). The research stages are presented in Figure 1.

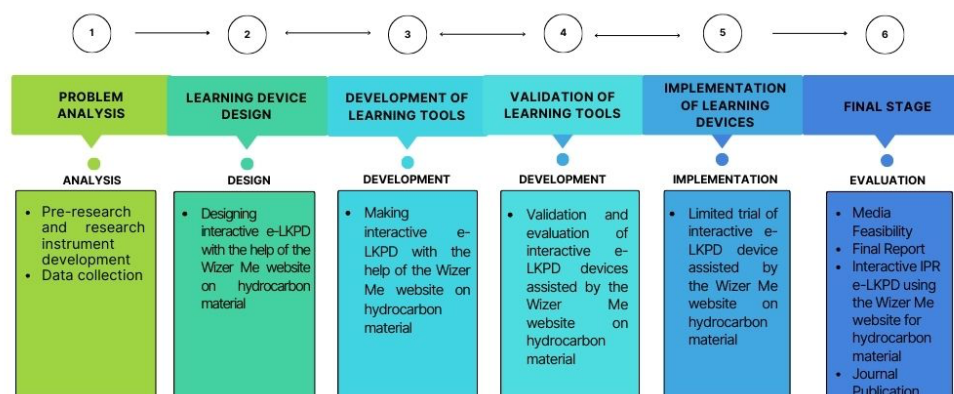


Figure 1. Research flow chart using the ADDIE model

The initial stage is the pre-research needs analysis stage, which includes a literature review, classroom observation, and an assessment of the school environment conducted at SMA Negeri 1 Gedangan, Sidoarjo. The first or preparatory phase of research and development is the preliminary investigation. The first of three processes at this stage is the literature study, which is (1) an investigation into ideas or theories pertaining to the model or product that has to be created. Additionally, at this stage of the literature study, a study is conducted on research findings that are pertinent to the research that will be conducted, such as pre-research and research instruments; (2) a field survey, which is an activity that involves gathering data in the field to gauge the need for the product to be developed; and (3) the process of identifying students' learning needs in order to create learning objectives and select learning materials that meet those needs is known as student analysis. The second stage in the design of media devices involves creating an interactive e-LKPD based on CTL, assisted by the Wizer.me website. This stage aims to design the learning media that will be developed, namely, interactive e-LKPD. The third stage is development, which involves creating an interactive e-LKPD based on CTL (Contextual Teaching and Learning), utilizing the Wizer.me website for assistance. This stage also involves validating and evaluating the interactive e-LKPD tool based on the Contextual Teaching and Learning (CTL) framework, assisted by the Wizer.me website, as well as revising the media. The resulting product will be

reviewed by three validators, including a chemistry teacher and two chemistry lecturers. If it meets the legal requirements, a trial of the research media developed will be carried out.

The fourth stage is implementation, which involves student reactions to the interactive e-LKPD and a limited trial of interactive e-LKPD media devices. At this point, limited learning activities will be used to test the outcomes of the interactive e-LKPD development. The purpose of the restricted trial is to ascertain how the improved product affects learning quality, including efficacy and efficiency, in order to be utilized as a learning tool that can increase participants' learning independence. The one-group pretest-posttest design is the study design used in the e-LKPD implementation. In this system, a single group is chosen at random and given a pre-test to establish the starting conditions before instruction. Following the administration of treatment (X) in the form of CTL-based learning, the group is given post-test questions at the final observation.

The fifth step is evaluation, which comprises final research and the interactive e-LKPD feasibility test. The goal of this research is to enhance students' learning independence by using an interactive e-LKPD based on CTL (Contextual Teaching and Learning), supported by the Wizer.me website. This type of learning tool can be used for hydrocarbon content. The participants in this study were MIPA-5 12th-grade students. The data sources used were from the results of student needs analysis interviews, validity sheets, and pre-test and post-test sheets. Meanwhile, the data collection techniques were by interview methods, giving tests, and also using questionnaires. Where the test method is used to obtain data in the form of es scores as student learning outcomes and also validation data from the validator. After the data is obtained, the data analysis steps are carried out, including needs interview results, validation questionnaires, and student test results. Data from the interactive e-LKPD validation questionnaire, based on CTL, were subjected to both descriptive and quantitative analysis. The information gathered was utilized to assess the validity of the interactive e-LKPD based on CTL. Scoring was based on the Likert scale as shown in Table 1.

Table 1. Likert Scale with Five Scales

Value/Score	Statement
5	Very Valid
4	Valid
3	Quite Valid
2	Less Valid
1	Invalid

(Riduwan, 2016)

Each indicator is subjected to a mode analysis of the evaluation outcome data. The learning materials are deemed "Valid" when they receive a score of 4 or higher. The descriptive quantitative analysis of the student response questionnaire data provided an evaluation of e-LKPD use based on the study's findings. The usefulness of the developed interactive e-LKPD based on CTL was assessed using the findings of the analysis of the student response questionnaire. Scoring was done based on the Guttman scale score shown in Table 2.

Table 2. Guttman Scale Score

Answer	Value	Score
Yes	1	0
No	0	1

(Riduwan, 2016)

Percentages were then used for analysis of the collected data. The percentage is then calculated by dividing the sum of the scores for each component by the total number of responders, and then multiplying the result by 100%. The results of the practicality percentage are interpreted as scores for each criterion in Table 3.

Table 3. Percentage of Practicality Criteria

Percentage (%)	Criteria
0 – 20	Not Practical
21 – 40	Less practical
41 – 60	Quite Practical
61 – 80	Practical
81 – 100	Very Practical

(Riduwan, 2016)

Based on the table, an interactive e-LKPD can be considered practical or very practical if the practicality percentage is $\geq 61\%$. The efficiency of interactive e-LKPD based on Contextual Teaching and Learning (CTL) in

enhancing student learning outcomes is assessed through the examination of test result data. This is done by looking at the students' pre-test and post-test scores on acid-base content. Using the N-gain analysis method, the following formula can be used to determine the improvement in student learning outcomes: Then, the obtained N-gain score is interpreted in Table 4.

Table 4. N-gain scoring table

N-gain score <g>	Category
$g \geq 0.7$	High
$0.7 > g \geq 0.3$	Medium
$g < 0.3$	Low

(Hake, 1998)

Analysis of student learning outcome data can be seen to determine student completion by comparing the pre-test and post-test results. Increases in the N-Gain Value indicate improvements in student learning outcomes. An individual completeness analysis can be accumulated into the following formula. According to the Criteria Achievement of Learning Objectives (KKTP), interactive e-LKPD based on Contextual Teaching and Learning (CTL) is considered an effective learning medium if it achieves the completeness of individual learning outcomes with a value of ≥ 85 . The classical completion might be set at $\geq 85\%$. The data from the student independence questionnaire were analyzed descriptively and quantitatively. Scoring was done based on the Likert scale score, as shown in Table 5.

Table 5. Likert Scale Score

Criteria	Score
Never	1
Seldom	2
Often	3
Always	4

(Riduwan, 2016)

Next, after being calculated, the percentage obtained is interpreted based on the following criteria. The analytical approach can be used to calculate the increase in students' learning independence, expressed as n-gain.

Table 6. Learning Independence Category

Percentage (%)	Criteria
0-20	Very not independent
21-40	Lack of independence
41-60	Quite independent
61-80	Independent
81-100	Very independent

(Riduwan, 2016)

RESULT AND DISCUSSION

Based on data obtained from research that has been conducted at SMA Negeri 1 Gedangan, Sidoarjo Regency. The class has 24 active students. The following is a description of the research results on interactive e-LKPD, based on CTL, described through the stages of the ADDIE model. An initial analysis was conducted prior to the research to create a profile of learning activities, particularly regarding the material of hydrocarbon chemistry, at State SMA Negeri 1 Gedangan in Sidoarjo Regency. This analysis was conducted using an observational approach specifically for teaching chemistry at the institution. Chemistry teacher interviews revealed that considerable effort is required to facilitate students' independent learning, as students often lack motivation while learning chemistry (Gabel, 1999; Taber, 2021). The intangible nature of chemistry makes it hard for students to conceptualize, resulting in lower levels of engagement and performance (Acar & Tarhan, 2007; Jong, 2023). Research has shown that students who struggle with understanding scientific abstractions tend to develop negative attitudes toward learning, which can adversely affect their performance (Harris, 2021; Lee, 2022; Smith, 2022). To address this challenge, the researchers posed several questions to teachers regarding the utilization of electronic learning resources, specifically e-LKPD, for enhancing chemistry learning. The results showed that although e-teaching resources can increase students' engagement, CTL-based interactive e-LKPDs, aligned with the independent learning curriculum, had not been explicitly implemented in the institution's chemistry lessons (Nguyen, 2023; Patel, 2024). Digital tool use within the subject area of science education is widely recognized as effective in supporting conceptual learning, promoting student autonomy, and facilitating collaborative learning (Aksela, 2019; Chen, 2020; Thompson, 2024).

Furthermore, web-based technologies, such as Wizer.me, provide an interactive, adaptive, and multimedia-rich learning process that promotes independent learning (Brown, 2021; Evans, 2023; White, 2024). The availability of digital worksheets enables students to learn content at their own pace, thus facilitating understanding and recall (Kong, 2021; Tsai, 2023; Wang, 2022). Literature supports the notion that e-learning fosters a student-centered pedagogy and facilitates independent learning processes through interactive feedback systems and real-time evaluation (Lai, 2021; Misbah, 2023; Tondeur, 2021). Online learning environments offer the potential for student interaction, critical thinking, and collaboration, which are essential attributes in the practice of chemistry education (Dabbagh, 2020; Jong, 2023). The utilization of interactive e-LKPDs aligns with current trends in educational technology, as computer-based systems have been found to enhance learning motivation, autonomy, and achievement in science disciplines (Harris, 2021; Smith, 2022; Wang, 2022). As it is, the utilization of interactive e-LKPDs through Wizer.me is indicative of an innovative approach to solving learning problems in hydrocarbon chemistry and enhancing the higher level of independence and participation of students in the process. This planning stage follows the examination of learning and learning materials using an interactive e-LKPD based on the Contextual Teaching and Learning (CTL) approach. The design of the media to be used later, modifications to the content, and several indicators are employed to carry out this media planning, aiming to enhance the quality of student learning. At this point, the instruments and learning resources that will be used later in student learning activities are also prepared.



Figure 2. (a) CTL-based e-LKPD cover on hydrocarbon material, (b) Independent learning video feature on e-LKPD, (c) One phase of CTL-based learning on e-LKPD to train students' learning independence

Validation of the interactive e-LKPD based on CTL developed focuses on several aspects, namely the suitability of the material, independence, presentation, and CTL. The validity criteria of a product are based on two key aspects: relevance/content validity (content validity) and consistency/construct validity (construct validity) (Azizah & Dwiningsih, 2025). Before e-LKPD is used in the learning process, validation is necessary to determine its feasibility.

Table 7. Table of Validation Result Based on a Likert Scale

Content	Score	Criteria
Content	4	Valid
Construct	5	Very Valid
Aspects of CTL suitability	5	Very Valid

Based on the scores obtained, three aspects of the assessment received a mode value of 5, and one aspect received a mode value of 4, indicating that the interactive e-LKPD based on CTL falls into a very valid category (Lutfi, 2021). The validity of the developed media is significant for experts to consider because it can complement the shortcomings of the existing media. At the validation stage, suggestions and input were obtained from the three validator teams, which were used as considerations for making revisions so that the interactive e-LKPD based on CTL can be used properly. In this case, the interactive e-LKPD based on CTL that was developed can be considered feasible for use in learning. At the stage of implementation, learning is being implemented at SMA Negeri 1 Gedangan, Sidoarjo Regency, using an interactive e-LKPD based on CTL (Contextual Teaching and Learning), which has been developed and declared valid by the validators. The design of this study employs a one-group pretest-posttest design, which is tested in a single experimental class. The purpose of this learning implementation analysis is to determine the effectiveness of implementing learning

activities with the help of interactive e-LKPD learning media based on the Contextual Teaching and Learning (CTL) approach in improving the quality of learning. At the implementation stage, observation activities were conducted with students to identify their activities during the limited trial of the LKPD that had been developed (Dwiningsih et al., 2024). The implementation of this learning was observed by the chemistry teacher for class XI A2. Learning activities were carried out for three meetings (3 x 45 minutes).

Table 8. Media Implementation Observation Results

Observed Aspects	Meeting 1	Meeting 2	Meeting 3	Average
Ability to Unlock Learning	92%	93%	95%	93%
Learning Process Implementation	87%	90%	92%	90%
Learning Steps	85%	85%	85%	85%
Evaluation	80%	80%	85%	82%
Ability to Close Learning	92%	92%	92%	92%
Average Implementation Observation Result				88%

Based on Table 8, the average percentage obtained is 88%, indicating that learning using the interactive e-LKPD based on CTL (Contextual Teaching and Learning) has been carried out in a very practical category. At this level, the final step in the ADDIE development methodology is evaluation, which assesses the usefulness and practicality of the interactive e-LKPD based on CTL (Contextual Teaching and Learning). Using the learning implementation observation questionnaire approach, the usefulness of the created interactive e-LKPD based on CTL is evaluated. The test technique, which involves administering a pre-test, post-test, and questionnaire of student responses regarding their use of the interactive e-LKPD based on CTL during learning activities, is used to determine the efficacy of the developed interactive e-LKPD. From the results of the pre-test and post-test that have been carried out in this study, the values obtained are displayed in Figure 3.

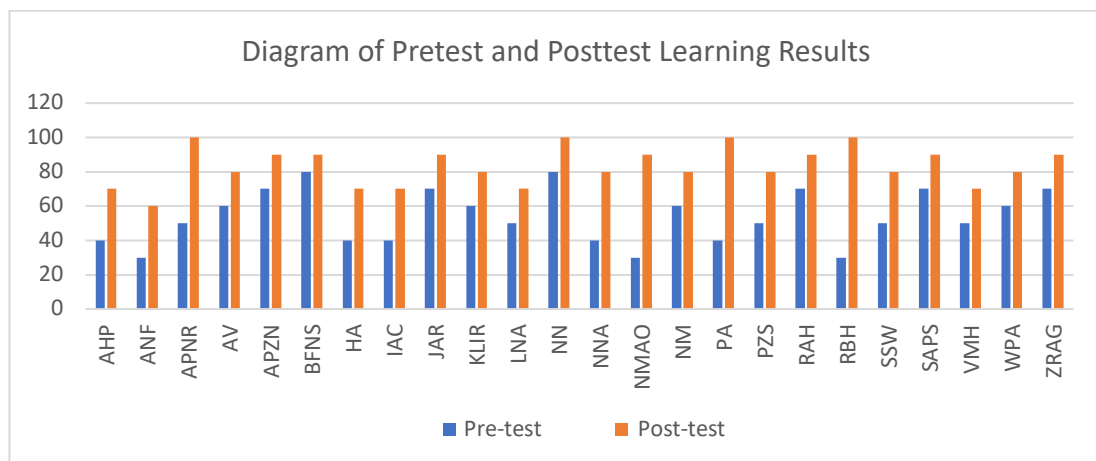


Figure 3. Pre-test and Post-test Learning Results

The average pre-test score prior to media development was summarized as 66.67. Following media development, the average post-test score was reported to be 82.08. Evaluations were then conducted using statistical tests based on the students' pre-test and post-test findings. Whether or not the prerequisite test is normally distributed and homogeneous is used to determine the students' pre-test and post-test scores in the trial class. The normality and homogeneity test yielded a significance value greater than 0.05, indicating that the pre-test and post-test results of the trial class's students are homogeneous and normally distributed.

After conducting the prerequisite tests, which included normality and homogeneity tests, the paired t-test was then performed. Based on the paired t-test results table, the results obtained were rejected because the significance was <0.05 . In the results obtained in the trial class, there were significant differences before being given treatment (pre-test) and after being given treatment in the form of CTL-based interactive e-LKPD learning tools on hydrocarbon material to increase students' learning independence. These results show an increase in students' pre-test and post-test results.

Table 9. N-gain Score of Pre-test and Post-test

Test Type	Average Score		Gain factor $<g>$	Criteria
	Pre-test	Post-test		
N-gain	53,75	83,33	0,6369	Currently

The efficiency of CTL-based interactive e-LKPD on hydrocarbon material to boost students' learning

independence was then examined using an N-gain analysis, which was created with the goal of enhancing the quality of learning. The n-gain score is used to calculate the n-gain, which is then separated into three categories: low, medium, and high (Riduwan, 2016). Improved learning outcomes are achieved by combining n-gain analysis with test procedures, specifically pre-tests and post-tests. Since the n-gain test result was 0.6369, it falls into the middle range. The interpretation of the n-gain value also demonstrates this increase. States that 63.6905% of n-gain test results fall into the quite effective category when interpreted in the n-gain effectiveness category (Hake, 1998). The Response Questionnaire, which students receive via Google Forms, can be used to determine the effectiveness of the CTL-based interactive e-LKPD on the produced hydrocarbon material. The assessment included in the student response questionnaire is conducted using the Guttman scale. This questionnaire consists of twenty questions. Students fill out this student reaction form after learning about the produced hydrocarbon material using an interactive e-LKPD that is based on CTL. The gathered data is then examined using the Guttman scale score. According to the student response assessment, 95.83% of pupils in the highly practical group achieved high scores (Riduwan, 2016). Students completed the Student Learning Independence Questionnaire via Google Forms to assess the viability of using an interactive e-LKPD based on CTL for hydrocarbon content, aiming to enhance student learning independence. A Likert scale was used for the assessment in the Student Learning Independence Answer Questionnaire. The questions in this questionnaire consist of five indicators: discipline, responsibility, initiative, motivation, and self-confidence, totaling 25 questions.

Table 10. Development of Student Learning Independence after learning using CTL-based interactive e-LKPD media

Indicators	Item	Total Score
Discipline	I completed the exercises on e-LKPD on time according to the schedule given. (Positive Statement)	87
	I often skip the exercises in e-LKPD even though there is enough time. (Negative Statement)	63
	I arrange study time to do assignments in e-LKPD in a planned manner. (Positive Statement)	82
	I rarely open e-LKPD according to the predetermined study schedule. (Negative Statement)	75
	I consistently use e-LKPD to study even without teacher supervision. (Positive Statement)	76
Responsible	I am responsible for completing all the exercises available in e-LKPD. (Positive Statement)	78
	I often ignore assignments in e-LKPD because I find them less interesting. (Negative Statement)	86
	I double-checked my answers before submitting the exercises in e-LKPD. (Positive Statement)	84
	I rarely complete assignments in e-LKPD unless a teacher supervises me. (Negative Statement)	83
	I feel responsible for the learning outcomes I get from e-LKPD. (Positive Statement)	86
Initiative	I am seeking additional references to understand the questions in e-LKPD better. (Positive Statement)	82
	I wait for instructions from the teacher before using e-LKPD. (Positive Statement)	73
	I try to answer difficult questions in e-LKPD without help from others. (Positive Statement)	69
	I rarely seek additional solutions if I encounter difficulty with questions in e-LKPD. (Negative Statement)	69
	I try to use additional features on the website to help my understanding. (Positive Statement)	73
Motivation	I feel more enthusiastic about learning by using interactive e-LKPD. (Positive Statement)	81
	I often lose my enthusiasm when using e-LKPD because I find it difficult. (Negative Statement)	78
	I still try to complete the exercises in e-LKPD even though I face obstacles. (Positive Statement)	81
	I rarely use e-LKPD if there is no assignment to be collected. (Negative Statement)	69

Indicators	Item	Total Score
Self-confident	Statement) I feel motivated to study the material more deeply after using e-LKPD. (Positive Statement)	82
	I am confident that I can complete all the questions in e-LKPD accurately. (Positive Statement)	78
	I often feel doubtful about my answers in e-LKPD even though I have thought it through carefully. (Negative Statement)	55
	I am confident discussing the answers I provided in e-LKPD with friends. (Positive Statement)	83
	I rarely feel confident in my ability to use the features in e-LKPD without assistance from a teacher. (Negative Statement)	60
	I feel capable of achieving good learning outcomes through the use of e-LKPD. (Positive Statement)	80

Based on the results of the analysis of the Student Learning Independence Instrument, the average weighted score obtained from the respondents was 76.25. This value was interpreted through a calculation in which the minimum possible score (X) was determined by multiplying the lowest Likert score (1) by the number of respondents (24), resulting in 24. Meanwhile, the maximum possible score (Y) was calculated by multiplying the highest Likert score (4) by the number of respondents (24), yielding 96. Using the index formula, the total score was divided by the maximum score (Y) and multiplied by 100, resulting in $76.25 \div 96 \times 100\% = 79.42\%$. Students completed this questionnaire after learning was conducted using an interactive e-LKPD based on CTL on the hydrocarbon material that had been developed. The results of the student response assessment were 79.42%, categorized as practical or effective (Andriani & Dwiningsih, 2024).

During the interactive media design process, the researcher initially planned to use the Wizer.me platform in creating an interactive e-LKPD due to its features that support interactive learning. However, when the research was conducted, the Wizer.me website underwent a change in service policy, which limited access to most of its main features to premium users. To purchase a premium account, payment is required using a debit from a foreign bank, as payments are not accepted through domestic banks. Therefore, the researcher could not continue the research using the website, and the researcher decided to switch to using liveworksheets as an alternative to creating interactive e-LKPD, as its features can be accessed for free. Although liveworksheets has interactive features, this transition requires readjustment to the previously prepared learning media design, thus increasing the processing time and revalidation process.

CONCLUSION

Based on the study's findings, the following conclusions can be reached: the interactive e-LKPD based on CTL is highly valid, with a score of 88.79%, categorized as very valid. The practicality test results show a 95.83% positive student response, while 79.42% of students demonstrated independent learning, indicating the practicality and effectiveness of the approach. The n-gain test results, at 63.69%, also attest to its effectiveness in fostering student learning independence in hydrocarbon content. Developing this e-LKPD is worthwhile, although it requires a premium subscription to access certain interactive features on Wizer.me. Other options, such as Liveworksheet, which provides automatic saving and correction of student responses, may be considered by future researchers.

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