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Contextual Teaching and Learning Interactive Media in Redox Reaction Concept for Improving Critical Thinking and Self-efficacy

Abdul Hamid[1], Gita Maharani[1], Muhammad Kusasi[1], Rusmansyah[1]*, and Tien Tien Lee[2]
[1]Department of Chemistry Education, Faculty of Teacher Training and Education, Universitas Lambung Mangkurat, Banjarmasin, Indonesia
[2]Department of Chemistry, Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris, Perak, Malaysia
**Email: rusmansyah@ulm.ac.id*

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Abstract

Many students find redox reactions challenging due to educators focusing solely on imparting knowledge without real-world connections. This approach limits critical thinking and reduces students' self-efficacy. To address these issues, fostering creativity and developing interactive learning materials are essential solutions. This research aims to create contextual teaching and learning (CTL) based interactive learning media for redox reactions. This media focuses on validity, practicality, and effectiveness in enhancing students' critical thinking skills and self-efficacy. The research framework employed in this study follows a research and development method with an analysis, design, development, implementation, and evaluation (ADDIE) model, with a research subject of 31 students. The results showed that interactive learning media was declared valid by media experts and material experts with an average score of 92.50% (high validity category). Media is very practical based on readability tests, students' responses, teachers' responses and observation sheets average percentage of 85.92%. It is also proven to increase critical thinking skills in high effective category (N-gain 0.81), and increase self-efficacy in moderate category (N-gain 0.65).

Keywords: contextual teaching and learning, critical thinking skills, redox concepts, self-efficacy

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1. Introduction

Education is one aspect that plays a significant role in shaping the individuals needed by the times. Education is a means within knowledge and skills in such a way through the learning process so that superior individuals are formed in the field of information technology and transform behavior and humanity as well as one's abilities and skills in thinking, including critical thinking, problem-solving, metacognition, communication, collaboration, innovation, and creativity, as well as information literacy (Mardhiyah et al., 2021).

Education plays a crucial role in shaping individuals who can meet the demands of the times by developing knowledge, skills, and behaviors essential in fields like information technology. Through the learning process, education enhances technical competencies and transforms behavior, humanity, and cognitive abilities. The multifaceted impact of education includes fostering critical thinking, problem-solving, metacognition, communication, collaboration, innovation, creativity, and information literacy (Ainiyah & Khusnah, 2019; Budiyanti et al., 2022; Widyastuti, 2020; Zuhdi et al., 2021). By integrating family, school, and community education institutions, character education is emphasized to address complex future challenges, ensuring individuals' holistic development and improving human resources (Ainiyah & Khusnah, 2019; Budiyanti et al.,

2022). Education is a lifelong journey that empowers individuals to contribute meaningfully to society, emphasizing the importance of ethical and moral values alongside intellectual growth (Ainiyah & Khusnah, 2019).

Education in the 21st century emphasizes critical thinking skills, and mastery of technology is seen as the base, which is very important to master as it is reading and writing (Muliastrini, 2020). Critical thinking ability is a high-level thinking ability that emphasizes the basis of logical and rational beliefs and can collect, classify, analyze, and evaluate various information and evidence to conclude problem solutions, hypothesis analysis, and research (Johnson, 2013; Nurjaman, 2020).

Critical thinking skills are abilities that students need to master because they help them solve problems in the form of stories or problems related to everyday life (Aldila Afriansyah et al., 2021; Syafruddin & Pujiastuti, 2020). Critical thinking can also form and increase students' self-confidence or self-efficacy in solving existing problems. Self-efficacy results from cognitive processes in the form of individual decisions or beliefs about their estimated ability to carry out several tasks or actions needed to achieve the desired results (Aharony & Gazit, 2020). Students' critical thinking skills in a lesson depend on their abilities, which means that in the process of developing critical thinking skills, students must have self-confidence and confidence in their abilities (self-efficacy) so that the better the self-efficacy, the better the ability to think critically too (Ginting et al., 2023).

Chemistry lessons train critical thinking abilities and skills through formulating problems, thinking logically and systematically, analytically, critically, and creatively, and innovation through cooperation and collaboration. Chemistry is a science that answers the questions of what, why, and how of natural phenomena related to the composition, structure and properties, change, dynamics, and energetics of substances (Meutia, 2022).

The concept of redox is one of the materials in chemistry lessons that has abstract characteristics and requires proof of activity search to convey to students to investigate, analyze, and conclude the results of their research. Redox is an abstract material because in the reaction, there is a transfer of electrons, release and acceptance of oxygen, and changes in oxidation numbers, and it is closely related to everyday life (Koimah & Muchtar, 2023).

Critical thinking skills, which are very important to be developed in chemistry lessons, have not been supported by good field conditions. Educators still often make learning tools that do not facilitate students to think critically, and the learning strategies do not accommodate all the characteristics of students' academic abilities (D. D. Lestari & Muchlis, 2021). Conventional learning models such as lectures assisted by the use of learning media in the form of textbooks and hand-outs are also often used by educators in the learning process, so educators have difficulty developing students' critical thinking skills (Fadilah et al., 2022; Ramdani et al., 2021).

The solution to overcome this problem is to improve the teacher's teaching style by applying the Contextual Teaching and Learning (CTL) model. CTL is a learning model that can increase students' activities, motivation, self-efficacy, and critical thinking skills through activities connecting knowledge with everyday life so that in learning, there is not only a transfer of knowledge, but students can learn directly and naturally with the working principle. and experience (Surata & Marhaeni, 2019).

The learning model is said to be able to be successfully applied if it can achieve the learning objectives, and to achieve its success, the use of learning media can support it. Learning media is a tool that helps clarify meaning in delivering material during the learning process (Rionanda et al., 2022).

Learning media that have been influenced by technology produce innovations in the form of media that are not only visible or audible but also interactive, which is being able to provide interactions or responses to users such as response answers, decision choices, and others. Learning media that utilize technology can make the learning atmosphere more attractive, students become more active and critical, and learning objectives can be adequately conveyed (Salsabila & Aslam, 2022).

Good learning media for chemistry lessons not only utilize technology but also must be able to represent abstract material. Interactive learning media based on Contextual Teaching and Learning (CTL) is an example of learning media that can explain abstract concepts through activities that link knowledge with everyday life so that learning is more than just transferring knowledge; it allows students to learn directly and naturally with the principles of work and experience (Muliaman et al., 2022; Surata & Marhaeni, 2019).

Interactive learning media developed with the Contextual Teaching and Learning (CTL) model have been shown to enhance students' critical thinking skills and self-efficacy by integrating real-life experiences into the learning process (Rahayu et al., 2023; Rahim, 2022; Sastra et al., 2023; Sugiarto, 2020). By focusing on concepts like circular motion and simple harmonic motion, these interactive media encourage students to apply their knowledge in practical situations, fostering a deeper understanding of the material and improving their problem-solving abilities (Rahim, 2022; Sastra et al., 2023). Additionally, research on digital comic media based on CTL principles has demonstrated increased student motivation and conceptual comprehension in scientific learning, indicating the effectiveness of contextual approaches in education (Rahayu et al., 2023).

Research on digital comic media and the Contextual Teaching and Learning (CTL) approach has consistently shown positive outcomes in education. Studies have revealed that implementing CTL-based digital comic media leads to improved student conceptual comprehension and motivation in scientific learning (Rahayu et al., 2023). Additionally, the use of the CTL approach online with Edmodo has been found to significantly increase motivation and learning outcomes in Physics, specifically on the concept of static fluids (Lestari, 2023). Moreover, the effectiveness of an ethnoscience-based CTL model on students' motivation in learning science has been demonstrated, highlighting the benefits of contextual teaching methods (Anjani et al., 2023). Furthermore, research on the CTL approach in mathematics education has indicated a positive impact on creative thinking skills and learning outcomes, emphasizing the importance of contextual approaches in enhancing student performance and engagement in various subjects (Santoso et al., 2023). Lastly, a study on the CTL model assisted by realia media has shown significant differences in student learning outcomes compared to conventional models, further supporting the effectiveness of contextual approaches in education (Santoso et al., 2023).

Research studies, such as those by Simanjuntak et al. and Risma et al., have demonstrated the effectiveness of interactive media-assisted inquiry learning in enhancing students' critical thinking skills, particularly in subjects like form and energy change in science (Simanjuntak et al., 2022; Ulum et al., 2023). These studies emphasize the positive impact of interactive learning methods on cognitive development by engaging students actively in the learning process, fostering creativity, and improving problem-solving abilities (Simanjuntak et al., 2022) (Ulum et al., 2023) (Sastra et al., 2023). The use of tools like Padlet and picture card media has been shown to significantly boost students' critical thinking skills, as evidenced by the notable improvements in pretest-posttest scores and the high efficiency levels of the interactive learning media employed in these studies (Sastra et al., 2023; Ulum et al., 2023). Additionally, the implementation of interactive multimedia-based guided inquiry has been found to enhance generic science skills and elicit positive student responses,

further underscoring the benefits of interactive media in promoting cognitive growth and academic success (Wardani et al., 2023).

Interactive learning media in the form of Google Sites websites is an innovation in learning that utilizes technological developments. Interactive learning media in the form of websites is easily accessible via smartphones and other digital devices and is preferred by students because it is faster and more practical. Text, images, graphics, videos, and animations in these media can provide a clearer picture of the subject matter to improve students' self-efficacy (Solikhin & Wijanarko, 2021).

The conclusion drawn from the discussion above is that it is necessary to develop CTL-based interactive learning media using Google Sites in chemistry learning redox concept material that can facilitate understanding of the material so that students' critical thinking skills and self-efficacy can increase.

2. Research Method

The creation of CTL-based interactive learning media with the help of Google Sites was developed using the Research and Development (R&D) method and followed the ADDIE development stages (analyze, design, develop, implement, and evaluate). Development research was carried out in class 10^{th} grade natural science one at MAN 1 with 33 students for the 2022/2023 academic year.

The research instrument used was a critical thinking test instrument (adapted from Facione) in the form of an eight-question essay test (each consisting of two questions for analysis, evaluation, inference and explanation) and a non-test instrument, in the form of a self-efficacy instrument (adapted from Albert Bandura) consists of 15 statements related to level of task difficulty, personal experience, role models, and social persuasion. Apart from that, researchers also used initial observation sheets regarding learning media needs, media validation sheets, readability questionnaires, student and teacher response questionnaires, and teacher practical observation sheets in learning using media.

3. Result and Discussion

The results of this development research are CTL-based interactive learning media on redox concept material. Media development is based on information obtained through observation, interviews, and questionnaires during the needs analysis stage. The information obtained from the analysis stage is learning media can facilitate students' understanding of chemistry, smartphones and the internet are the needs of students in learning, the learning media used are still in the form of student worksheet and power point, and students' critical thinking is influenced by the learning media used.

Developing interactive learning media using Google Sites is carried out because the resulting learning media is a website that can be accessed with various digital devices without installing an application. Google Sites is a website builder with many advantages, such as being easy to create, accessible, collaborative, and searchable (Rasapta et al., 2022).

Interactive learning media that have been developed are then validated to determine the feasibility of using media in learning during the implementation stage. Validation was carried out by five validators who measured the validity of the media in terms of general content, design, and language. Comments and suggestions from the validators included changing the page navigation color to a softer color to match the background color of the media, removing the background of the chemical equation image so that it matched the background color, and changing the presentation of practice questions using web-based games so that students will be more interested in using media and making the learning more fun. The average validation results from media expert and material experts were 92.50% (high valid category). The display

of the learning media that has been created can be seen in Figure 1.

Figure 1. Media Display

The results of the re-validation after the repairs were made are shown in Table 1 below:

Table 1. Media Validation Results

Aspect	Component	Value (%)
General	Creative and innovative Easy to use Interactive The questions are HOTS.	88.33
Fill	Material suitability Contextual Learning objectives	92.50
Design	Interface design Navigation and transitions Color and layout Media display design	97.50
Language	PUEBI compliant language clarity sentence clarity	91.67
Average		92.50
Description		Very Valid

The assessment results of the five validators in Table 1 show that CTL-based interactive learning media is very valid, with an average validity level of 92.50%, measured from general aspects, content, design, and language with several inputs. The material expert's assessment shows that the material presented has a material review and learning objectives that follow the chemistry subject syllabus and the steps of the CTL learning model. The content of learning media is also HOTS, which can hone students' critical thinking skills. Language assessment shows that the preparation of interactive learning media is easy to understand, according to language rules, sentence structure accuracy, spelling accuracy, and terminology consistency. Assessment of design aspects by media experts shows that CTL-based learning media developed with the help of the Google Sites website have met the expected standards of display of learning media by selecting colors, images, and backgrounds so that students are interested in learning. A graphic display that is clear and easy to understand can help users remember the information being studied. The validators declare the layout and design for icons and buttons to increase the attractiveness of the developed interactive learning media.

Interactive learning media that have been declared valid can be tested during implementation. The implementation phase provided data about the practicality and effectiveness of using media in learning. The practicality of the media was inferred from the measurement results using a readability questionnaire, a student and teacher response questionnaire, and observation sheets on the practicality of teachers using media. The results of the practicality test assessment are shown in Table 2.

Table 2. Practicality Test

Test Practicality	Value (%)	Description
Legibility	81.60	Very Practical
Response Participant educate	83.39	Very Practical
Response Teacher	82.50	Very Practical
Observation Practicality	96.20	Very Practical
Average	**86.00**	**Very Practical**

Table 2 shows that the legibility of the media is very good, so it is easy to understand. The response of students and teachers to the media is very good because smartphones, other devices, and the internet are commonly used in everyday life. The results of the observation sheet assessment were also very good, indicating that the media developed was easy for teachers to access, display, and

share. The results of the questionnaire and observation concluded that the practicality of CTL-based learning media was classified as very good or very practical, with an average practicality percentage of 86%. Measurements of the practicality of media with a percentage value of ≥81% are included in the very practical criteria (Oktafiana et al., 2020). Content on the occurrence of iron rusting contained in the learning media created can increase students' self-confidence and critical thinking. Students can watch this iron rusting phenomenon from the link provided https://youtu.be/sUwyDsnYpmE. The learning material discussed in the e-module covers the development of redox reactions, oxidation numbers and autoredox can be seen in in Figure 2.

Figure 2. Learning Material

The evaluation stage is the last step in the ADDIE development model, which is a process of evaluating learning media developed to investigate the effectiveness of media in increasing students' critical thinking skills and self-efficacy. The evaluation stage is also a pretest for students to determine their initial abilities and self-efficacy before studying redox concept material chemistry.

Critical thinking ability is measured using an essay test with four indicators: analysis, evaluation, inference, and explanation. The validity of the questions shows a value of 0.93 (high category), and the reliability is 0.74 (high category).

The effectiveness of CTL-based learning media in improving critical thinking skills can be seen from the learning completeness and achievement of each indicator during the pretest and post-test. Students are considered to have completed the lesson if they get a score equal to or more than the Minimum Completeness Criteriascore set by the Banjarmasin MAN 1 school, according to the 2013 curriculum, which is ≥ 75. Critical thinking skills based on learning completeness as shown in Table 3.

Table 3. Student Critical Thinking Ability Test Results

Category	Value Range	Number of Students			
		Pretest	Percentage (%)	*Posttest*	Percentage (%)
Very low	0 – 20	15	48	0	0
Low	21 – 40	9	29	0	0
Medium	41 – 60	7	23	0	0
High	61 – 80	0	0	11	35
Very high	81 – 100	0	0	20	65
Total		**31**	**100**	**31**	**100**

Table 3 shows that after the learning process using the CTL model assisted by Google Sites interactive media, students were able to complete the learning. Students achieved each critical thinking indicator well, and their critical thinking abilities increased (see students' pretest and posttest scores).

Table 4. Achievement of Critical Thinking Ability for Each Indicator

Indicators	Subskill	Level of Achievement (%)		Average		N-Gain	Description
		Pretest	Posttest	Pretest	Posttest		
Analysis	Write down the relationship between the various concepts used in solving the problem	33.33	84.95	31.00	79.00	0.77	High
Evaluation	Can write down problem-solving and determine other alternatives to solving problems	25.81	84.41	24.00	78.50	0.79	High
Inferences	Can conclude what is asked logically	23.12	84.95	21.50	79.00	0.80	High
Explanation	Can write down the final results and give reasons for the conclusions drawn	20.43	85.49	19.00	79.50	0.82	High
Average						**0.81**	**High**

Table 4 shows that the explanation indicator had the lowest achievement during the pretest. Students struggled to write the final results, draw conclusions, and give reasons. The cause of this problem is that students are still weak in reading, observing, and conducting discussions with fellow friends. Utami et al., (2020) said that having discussions when solving problems during learning provides a good opportunity for students to exchange thoughts or opinions to understand better the concepts being taught.

However, the explanation indicator experienced the most significant increase compared to other indicators, with an N-Gain score of 0.82. Students can adequately write down the final results and provide reasons for the conclusions made so that they form strong opinions. This ability is influenced by the use of CTL-based interactive learning media, which, with its constructivist syntax, makes students argue with each other with reasons that, according to them, are appropriate. Agnafia (2019) stated that explanation can train students to develop reasoning and critical thinking. The low achievement of each indicator of critical thinking skills at the pretest is because students are still weak in reading, observing, and conducting discussions with fellow friends. Hence, their understanding of concepts is low, and their critical thinking power is lacking.

The low achievement of critical thinking skills indicators at the pretest, such as reading, observing, and conducting discussions, may indeed be attributed to students' weak understanding of concepts and lack of critical thinking power (Saragih et al., 2019). Explanation plays a crucial role in developing critical thinking skills, as it requires students to state results, justify procedures, and present arguments effectively (Irani, 2006). Implementing strategies like self-explanation in reading activities can encourage students to think beyond the text, supporting critical thinking and deep comprehension (Fajrin & Pusparini, 2019). However, the effectiveness of self-explanation in fostering unbiased reasoning can vary based on the task complexity and the presence of reliable patterns, as it can either enhance or impair learning depending on the match between constraints and material structure (Williams et al., 2010). Therefore, addressing students' weaknesses in reading, observing, and discussions through targeted interventions and effective teaching methods like self-

explanation can significantly improve their critical thinking abilities over time.

The effectiveness of CTL-based learning media in increasing student self-efficacy is seen based on the results of each student's self-efficacy analysis and comparison of pretest and post-test results using the score gain test. Measurement of self-efficacy is carried out using a questionnaire containing statements regarding four aspects of self-efficacy, which are aspects of self-confidence in skills in dealing with situations that contain ambiguity, uncertainty, and pressure, aspects of belief in skills to increase motivation, cognitive skills, and action to achieve results, aspects of self-confidence to achieve predetermined goals, aspects of confidence in the skills to overcome problems that arise. The results of the self-efficacy analysis for each student are presented in Table 5.

Table 5. Results of Self-Efficacy Analysis

Category	Number of Students			
	Pretest	Percentage (%)	*Posttest*	Percentage (%)
Not good	0	0	0	0
Less good	14	45	0	0
Pretty good	17	55	0	0
Good	0	0	9	29
Very good	0	0	22	71
Total	**31**	**100**	**31**	**100**

The self-efficacy category of the students shown in Table 5, which is 45%, is included in the less good category, while the rest are in the pretty good category with a percentage of 55%. The low self-efficacy of the students at the pretest stage was due to their not being confident enough to understand the redox concept learning material well, judging from the characteristics of the abstract material and the CTL learning model, which was still foreign to them. The effectiveness of CTL-based interactive learning media in increasing students' self-efficacy in terms of the achievement of each aspect is shown in Table 6.

Table 6. Results of Achievement of Self-Efficacy for Each Aspect

Aspects of Self-efficacy	Achievement Level (%)		Average		N-Gain	Description
	Pretest	Posttest	Pretest	Posttest		
1	47.37	80.04	58.75	99.25	0.62	Medium
2	47.98	81.65	59.50	101.25	0.65	Medium
3	56.45	83.06	70.00	103.00	0.61	Medium
4	53.06	82.25	65.80	102.00	0.62	Medium
Average					**0.65**	**Medium**

The average value of students' N-gain self-efficacy shown in Table 6 above is 0.65, which is classified as moderate. Student achievement results in every aspect have increased due to the use of CTL-based interactive learning media. The syntax used in this interactive learning media is found to be activities related to one aspect of self-efficacy, which is self-confidence in completing tasks given in situations that contain factors of ambiguity, uncertainty and pressure. The syntax of asking questions is related to aspects of self-efficacy in the form of students' personal experiences and also role models from their friends who motivate and act to achieve maximum results. The syntax of constructivism is related to aspects of self-efficacy in the form of positive social persuasion so that support and contribute to increasing students' self-efficacy. CTL learning is assisted by interactive media which provides examples of problems from everyday life, such as the process of rusting iron, supporting students in increasing their self-efficacy.

4. Conclusion

The development research that has been carried out produces CTL-based interactive learning media assisted by Google Sites that have been tested for the validity of content, language, and design by experts with very valid criteria, obtaining a percentage of 92.50%. The practicality of interactive learning media was assessed based on the readability test, the responses of students and teachers, and the results of practical observations of teachers, which obtained a percentage of 86.00% with very practical criteria. The effectiveness test also shows an increase in critical thinking skills with a very high category and self-efficacy with a high category, as seen from the N-gain results in the pretest and post-test assessment, which are 0.81 and 0.65, respectively.

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