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Development of Digital Flashcard Learning Media Assisted by Quizlet Based on Contextual Teaching and Learning (CTL) Oriented to Critical Thinking Skills on Electrolyte and Non-Electrolyte Solution Material

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Abstract: Chemistry learning on electrolyte and non-electrolyte solutions is still abstract and difficult to visualize, so it requires digital learning media that can encourage active student involvement in critical thinking. This study aims to develop digital flashcard learning media assisted by Quizlet, based on Contextual Teaching and Learning (CTL), that are oriented towards critical thinking skills, to assess the feasibility of the media, teacher assessment, student responses, and to provide an overview of students' critical thinking skills after using the developed media. This research is a research and development (R&D) with the Lee & Owens model, which includes the stages of Analysis, Design, Development, Implementation, and Evaluation. The research subjects were grade XII high school students. The research instruments included validation sheets from material experts and media experts, teacher assessment questionnaires, student response questionnaires, and evaluation tests. Data were analyzed descriptively, quantitatively, and qualitatively. The results showed that material expert validation increased from 85% to 97% after revision, media expert validation increased by 90%, and teacher assessment increased by 90%, with a very feasible category. Student responses in the one-to-one trial were 86.6%, and in the small group trial were 86.25%, categorized as very good. The evaluation results, at 82.27%, indicate that students' understanding is in the very good category. Therefore, the digital flashcard learning media, supported by Quizlet and based on CTL, is highly suitable as an alternative learning medium for high school chemistry and has the potential to foster students' critical thinking skills.

Keywords: Contextual Teaching and Learning; Electrolyte and Non-Electrolyte Solutions; Flashcard Digital; Instructional Media; Quizlet.

Introduction

Education is the main foundation for developing quality, skilled, and highly competitive human resources in the era of globalization. 21st-century education demands mastery of critical, creative, collaborative, and communicative thinking skills in response to the rapid development of technology and information. 21st-century skills are essential competencies that must be integrated into the learning process to prepare students for the Industrial Revolution 4.0 and Society 5.0 eras. One of the main aspects of 21st-century learning is the thinking and work skills that students must master. These thinking skills include creativity, critical thinking, problem-solving, and decision-making. While working skills are the ability to work in a global and digital world, students must be able to communicate, collaborate, and work with individuals, communities, and networks. Students must also be able to master the tools for working [1].

Improving the quality of human resources (HR) through education focuses on developing higher-order thinking skills (HOTS), a crucial competency for preparing graduates to compete and adapt to changing times. One form of HOTS is critical thinking skills. Critical thinking skills are essential for problem-solving and decision-making. Therefore, developing critical thinking skills is crucial for students to achieve optimal learning outcomes [2].

Students' critical thinking skills can be trained, measured, and developed through teacher-provided stimuli during the learning process. Each individual has a different level of thinking ability. Bloom's Taxonomy in Education is designed to differentiate between lower-order and higher-order thinking skills. Bloom's Taxonomy in Education in the cognitive domain is classified into six: remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6) [3]. In line with the implementation of the Independent Curriculum, learning is directed to be student-centered and provide meaningful and contextual learning experiences [4].

One approach relevant to the Independent Curriculum's characteristics is Contextual Teaching and Learning (CTL). The Contextual Teaching and Learning approach is a learning concept that helps teachers connect material to real-life contexts, enabling students to construct their own understanding through direct experience. This approach is crucial in chemistry learning because many chemical concepts are abstract and complex [5]. Chemistry learning is often considered difficult because it involves microscopic and symbolic concepts that cannot be directly observed [6]. A comprehensive understanding of chemistry must encompass the interrelationships between the macroscopic, submicroscopic, and symbolic levels. However, in practice, students tend to memorize concepts without deeply understanding the relationship between these

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three representations [7]. This aligns with the statement that, in the chemistry learning process, students' critical thinking skills can be observed in how they respond to chemical problems encountered in everyday life [8]. Critical thinking is the ability to apply previously understood concepts, use strategies carefully, and present appropriate arguments when solving problems to obtain accurate, accountable results. Critical thinking skills are essential for students to face challenges and must be able to make decisions, consider and evaluate information, and determine the actions to be taken. Students with strong memories will be more critical in the learning process because their understanding is broader than that of students who just keep quiet and receive material without expressing opinions openly. This is supported by the statement that critical students tend to be more active in efforts to solve chemistry problems, including being active in asking questions to obtain clear information, being serious about working on existing problems in order to obtain logical solutions, expressing their opinions and ideas to criticize solutions that they think are rational, and being able to draw conclusions from existing mathematical solutions [9].

Learning chemistry, in particular, requires a strong memory and critical thinking skills. Furthermore, chemistry learning involves conceptual understanding, calculations, and memorization. One chemistry topic that frequently presents difficulties is the distinction between electrolyte and non-electrolyte solutions. Students struggle to differentiate between strong electrolytes, weak electrolytes, and non-electrolytes, and to understand the relationship between the number of ions and a solution's electrical conductivity. This situation highlights the need for innovative learning media that can help visualize concepts while connecting them to everyday life phenomena [10]. This learning is rooted in constructivism. Constructivism holds that knowledge acquired by humans is the result of individual construction, thereby rejecting the direct transfer of knowledge from one individual to another. Constructivist theory emphasizes that science is not simply a collection of facts or laws, but rather the product of human thought formed through ideas and concepts. In the context of science learning, this approach encourages students to actively construct their own understanding and develop critical thinking skills through direct involvement in the learning process [11].

Learning media plays a vital role in enhancing learning effectiveness. Learning media is an integral component of modern education that can increase active student engagement [12]. Using appropriate media can help convey abstract concepts more concretely and engagingly. In the context of digital learning, leveraging technology is a relevant solution. One platform that can be used is Quizlet, which offers flashcards, quizzes, educational games, and step-by-step exercises [13]. In addition, Flashcards are able to strengthen memory through structured repetition [14]. However, the use of these learning media needs to be designed more targetedly so that it not only improves understanding but also develops students' critical thinking skills through contextual, problem-based presentations of material.

This problem was reinforced by the results of an interview with a chemistry teacher at SMA Negeri 11 Muaro Jambi. The teacher stated that the curriculum used is the Independent Curriculum, with a KKTP of 75, yet approximately 70% of students still struggle to understand material on electrolyte and non-electrolyte solutions. These difficulties include the ability to distinguish between strong electrolytes, weak electrolytes, and non-electrolytes, understanding the ionization process, and relating the number of ions to electrical conductivity. The teacher also stated that learning is still dominated by the use of textbooks and printed worksheets, while interactive digital media has not been optimally utilized despite the school's adequate ICT facilities.

The results of a needs analysis questionnaire administered to 27 students in grade XII-F1B showed that 73% of students reported that chemistry learning remained difficult to understand because the concepts were abstract. As many as 84% of students felt more motivated when learning was made interesting and interactive. In addition, 81% of students liked the use of digital media in chemistry learning, and 80% considered digital media more helpful for understanding abstract concepts than printed media. According to the CTL approach, 84% of students stated that learning was easier to understand when linked to everyday life, and 78% expressed interest in using digital flashcards assisted by Quizlet. These data indicate a real need for interactive, contextually relevant digital learning media.

Based on the problems and needs analysis, this study developed a digital flashcard learning media assisted by Quizlet based on Contextual Teaching and Learning (CTL) oriented towards critical thinking skills on electrolyte and non-electrolyte solution material as an effort to create more interactive, meaningful chemistry learning, and encourage students' deeper understanding of concepts.

Research Methods

This study uses the Lee & Owens systematic development model as a procedural model. This model was chosen because it is suitable for developing digital flashcards using Quizlet-based CTL on electrolyte and non-electrolyte solutions. The development model by Lee and Owens (2004) consists of five stages: analysis, design, development, implementation, and evaluation, so that the development process is carried out systematically and directed [15].

The analysis stage identifies students' needs, characteristics, and problems in chemistry learning related to electrolyte and non-electrolyte solutions. The design stage includes defining the media structure, compiling content, and creating flashcard displays aligned with the CTL approach. Furthermore, the development stage involves creating learning media, integrating interactive features, and validating the product by experts to ensure its feasibility. The implementation stage involves conducting trials with students to determine the practicality and feasibility of using the media in learning. The evaluation stage aims to assess the effectiveness of the media and make improvements based on trial results and input received, ensuring the resulting media is truly suitable for use in the learning process.

The first stage is analysis, consisting of needs analysis, student characteristics analysis, learning objectives analysis, materials analysis, and educational technology analysis. The needs analysis was conducted through interviews with chemistry teachers at SMAN 11 Muaro Jambi and through questionnaires distributed to grade XII F1B students at SMAN 11 Muaro Jambi to identify learning problems and the need for interactive digital media. The

analysis of student characteristics aims to determine students' readiness and ability to use technological devices. Analysis of learning objectives and materials is conducted by reviewing Learning Outcomes, Learning Objective Flow, and Learning Objectives in the Independent Curriculum related to electrolyte and non-electrolyte solutions. The analysis of learning technology is conducted to determine the appropriate platform for media development. The objective of this stage is to establish a basis for media design appropriate to the needs and characteristics of learning.

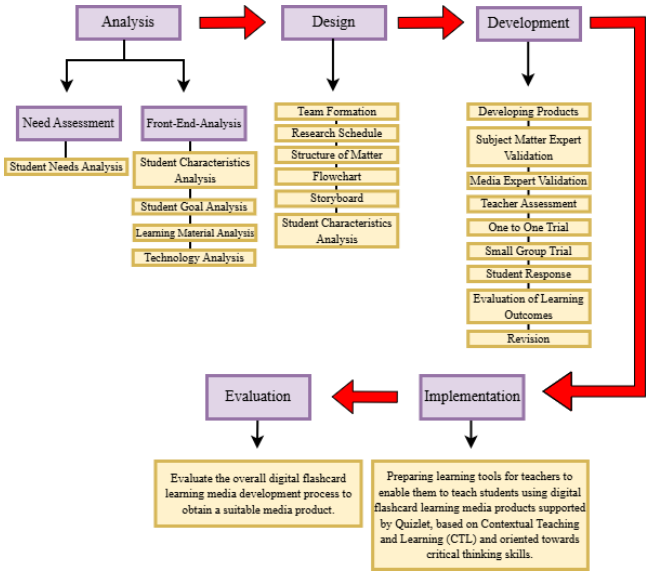

Figure 1. Lee & Owens Model Development Flow

The second stage is design. At this stage, researchers design the product based on the analysis results. Activities include developing concept maps and material structures, formulating indicators and learning objectives, developing flowcharts and storyboards, and designing flashcard displays that include core concepts, contextual examples based on the CTL approach, supporting illustrations, and practice questions. Furthermore, research instruments were developed in the form of validation sheets from material experts and media experts.

The third stage is development. At this stage, the product design is realized into digital flashcard media using the Quizlet platform according to the storyboard that has been prepared. The resulting initial product is then validated by material and media experts to assess content feasibility, language, presentation, visual appearance, and suitability with the CTL approach. The validation results, in the form of assessment scores and improvement suggestions, serve as the basis for product revisions until the media is conceptually and procedurally feasible. This stage marks the limit of the research implementation.

The fourth stage is implementation. Conceptually, this stage aims to test the product's use in learning to determine its practicality and student acceptance through extensive trials. However, in this study, the implementation stage was not implemented due to time and scope limitations.

The fifth stage is evaluation. Evaluation in the Lee & Owens model is conducted formatively at each stage and summatively after implementation. In this study, formative evaluation was conducted through expert validation and product revision during the development stage, while summative evaluation, through extensive field trials, was not conducted.

The trial subjects in this study were 10 12th-grade students from SMA Negeri 11 Muaro Jambi, and the trial was conducted in small groups. Class XII was selected based on the chemistry teacher's recommendation because it was considered active and representative of students' general characteristics. In addition, the students had studied the material on electrolyte and non-electrolyte solutions, thus aligning with the topic of the Contextual Teaching and Learning (CTL)-based digital flashcard media being developed. Ten students were selected based on variations in academic ability (high, medium, and low) to ensure the trial provides a comprehensive picture of understanding, ease of use, and acceptability of the media.

This study yielded both qualitative and quantitative data. Qualitative data were obtained through interviews with chemistry teachers and through comments and suggestions from subject-matter and media experts. Quantitative data were obtained from validation scores from subject-matter and media experts, teacher assessments, student response questionnaires, and evaluation test results. All data were used to assess the feasibility and quality of the CTL-based digital flashcard media, developed using Quizlet.

Data collection was conducted through complementary interviews and questionnaires. Interviews were used to identify learning needs and constraints, while questionnaires were used to obtain assessment scores and student responses as a basis for product revisions.

The research instruments included student needs analysis, material expert validation sheets, media expert validation sheets, teacher assessment questionnaires, student response questionnaires, and evaluation tests to see the level of student understanding after using the media.

Data analysis for this needs analysis instrument was carried out using a rating scale with the following formula:

$$\text{Percentage Score} = \frac{\text{total score}}{\text{criterion score}} \times 100\%$$

The scoring guidelines for student needs analysis instruments, material expert validation, teacher assessment questionnaires, student response questionnaires and evaluation tests.

Table 1. Scoring on the instrument is on a four-point scale.

Score	Score Interval	Scoring Criteria for Instrument Assessment	Scoring Criteria Product Eligibility
4	80,1%-100%	Very Good	Very Worthy
3	70,1%-80%	Good	Worthy
2	50,1%-70%	Not Good	Unworthy
1	0%-50%	Very Bad	Totally Unworthy

[16]

As for the scoring guidelines for media expert validation instruments. The validation instruments of material experts, media experts' validation, teacher assessment, and student response questionnaires are based on the percentage of scores, using the following formula:

$$\text{Average Score} = \frac{\text{number of scores obtained}}{\text{number of indicator items}}$$

$$\text{Percentage Score} = \frac{\text{number of scores obtained}}{\text{total score}} \times 100\ \%$$

Table 2. Scoring on the instrument is on a five-point scale.

Score	Score Interval	Scoring Criteria for Instrument Assessment	Scoring Criteria Product Eligibility
5	80,1%-100%	Very Good	Very Worthy
4	60,1%-80%	Good	Worthy
3	40,1%-60%	Poor	Less Worthy
2	20,1%-40%	Not Good	Not Worthy
1	0%-20%	Very Bad	Totally Unworthy

[17]

Results and Discussion

The result of this development research is a digital flashcard, supported by Quizlet, based on Contextual Teaching and Learning (CTL) on electrolyte and non-electrolyte solutions, designed to develop students' critical thinking skills. This digital flashcard media is designed to support the learning process and help students understand the concepts of electrolyte and non-electrolyte solutions through a more contextual, interactive, and engaging learning experience, thereby fostering students' critical thinking skills as they express opinions based on their own understanding. In line with the statement that one of the advantages of using flashcard learning media is that it is easy to remember, fun, etc [18]. Learning with flashcards or using letter cards as a play-while-learning medium can stimulate active learning, train students to solve problems, foster competition and harmony among students, build self-confidence, and encourage positive interactions. Media development is carried out by designing the material structure, learning cards, and content display tailored to the Learning Outcomes (CP), Learning Objective Flow (ATP), and Learning Objectives (TP) in the Independent Curriculum. Digital flashcard media is then organised into card sets on the Quizlet platform so students can easily access them on smartphones, laptops, or any other internet-connected device.

Analysis Stage

The analysis phase of this study aims to obtain a general overview of the learning conditions of electrolyte and non-electrolyte solutions at SMA Negeri 11 Muaro Jambi. The analysis was conducted through interviews with chemistry teachers and the distribution of needs questionnaires to 27 grade XII F1B students. The results of the analysis indicate that although the school has implemented the Independent Curriculum and utilized several learning methods, the use of interactive digital media in chemistry learning is still not optimal. Teachers also stated that students still experience difficulties in analyzing the concepts of electrolyte and non-electrolyte solutions, mainly because the material is abstract and tends to be delivered through lectures and textbooks.

The questionnaire results showed that 75% of students had difficulty understanding and learning about electrolyte and non-electrolyte solutions, 69% found the topic difficult, and 73% stated that the concepts were abstract. This situation indicates that teacher-centered learning has not fully encouraged students' active involvement in critical thinking. This is in line with research, which states that abstract chemical concepts require the support of interactive learning media so that students can be actively involved in the thinking process [6]. In addition, the material on electrolyte and non-electrolyte solutions is quite complex because it involves the concepts of ionization and electrical conductivity, which cannot be observed directly, thus requiring deeper analytical skills in various chemical representations [19].

The analysis also shows a need for more engaging and interactive digital learning media. 87% of students are interested in using digital media; 80% stated that the material would be more interesting if presented through the Quizlet application, and 84% stated that learning would be more meaningful if related to daily life. Analysis of student characteristics shows that 81% of students are accustomed to using smartphones or laptops, and 80% are more interested in digital media than print media. In terms of technological readiness, 96.9% of students own smartphones, and 90.6% of students stated that the school's internet facilities support information technology-based learning. These findings indicate that the learning environment is sufficiently prepared to support the use of digital learning media. The analysis also shows a need for more engaging and interactive digital learning media. 87% of students are interested in using digital media; 80% stated that the material would be more interesting if presented through the Quizlet application, and 84% stated that learning would be more meaningful if related to daily life. Analysis of student characteristics shows that 81% of students are accustomed to using smartphones or laptops, and 80% are more interested in digital media than print media. In terms of technological readiness, 96.9% of students own smartphones, and 90.6% stated that their school's internet facilities support information technology-based learning. These findings indicate that the learning environment is sufficiently prepared to support the use of digital learning media.

Overall, the analysis phase indicates that suboptimal use of interactive digital media and the lack of learning stimuli that encourage critical thinking are the main problems in learning about electrolyte and non-electrolyte solutions. Therefore, the development of digital flashcard media assisted by Quizlet, based on Contextual Teaching and Learning (CTL), is considered relevant to support the learning process. The CTL approach allows students to link concepts to real-life contexts, thereby encouraging active student involvement in analyzing, evaluating, and making critical decisions in learning [10].

Design Stage

The design stage is the process of designing digital flashcard learning media using Quizlet based on Contextual Teaching and Learning (CTL). This is carried out after the needs analysis stage is completed. At this stage, researchers systematically develop a product design to ensure alignment between learning needs and the media format to be developed. Media design refers to the Learning Outcomes, Learning Objective Flow, and Learning Objectives in the Independent Curriculum for electrolyte and non-electrolyte solutions. Furthermore, this stage also determines media specifications, the structure of material presentation, and

digital flashcard formats designed to encourage students' critical thinking skills.

The material in the media is systematically organised into four main sub-chapters: the concept of electrolyte and non-electrolyte solutions; the properties of strong and weak electrolyte solutions; the classification of strong, weak, and non-electrolyte solutions; and the role of electrolyte and non-electrolyte solutions in everyday life. The preparation of the material aims to support the development of students' higher-order thinking skills, which include analytical skills (C4), evaluation (C5), and creation (C6). The media is developed as digital flashcards that can be accessed through the Quizlet app or website, allowing students to learn flexibly both in and out of the classroom. Each sub-chapter is organised as a set of cards aligned with learning objectives, totalling 26 cards: 7 in the first sub-chapter, 6 in the second, 5 in the third, and 8 in the fourth.

At the design stage, a flowchart was also prepared to systematically illustrate the media development process, from material planning and flashcard structure preparation to uploading media to the Quizlet platform. In addition, a storyboard was prepared as a visual design illustrating the appearance of each flashcard, including the material title, questions or stimuli, answers or brief explanations, and everyday-life examples, in accordance with the CTL approach. The preparation of the flowchart and storyboard aims to ensure that the content structure and media appearance are designed in a structured manner before entering the development stage, and to provide stimuli that encourage students to think critically.

The design phase is carried out systematically through the development of material structures, flowcharts, and storyboards oriented toward learning outcomes. Media development also draws on several theoretical foundations of learning. Cognitive theory is applied through a structured and gradual presentation of material, making it easier for students to grasp concepts [20]. Behaviorism theory focuses on observable changes in behavior as a result of learning experiences reflected in the provision of practice and direct feedback through the learn and test features on Quizlet [21]. Meanwhile, the constructivism theory emphasizes that knowledge is built by students through active interaction with their environment and their own experiences are realized through the application of CTL, which links the concept of electrolyte and non-electrolyte solutions with phenomena in everyday life, so that learning becomes more meaningful for students [22]. Overall, the design phase yielded an initial draft of a Quizlet-assisted, CTL-based digital flashcard media focused on critical thinking skills. This included material structure, learning card design, and a presentation flow integrated with the learning objectives of the Independent Curriculum. This design then served as the basis for the subsequent development of learning media.

Development Stage

The development phase resulted in a Quizlet-based digital flashcard learning resource, grounded in Contextual Teaching and Learning (CTL), for electrolyte and non-electrolyte solutions. The product was developed in accordance with the Learning Outcomes, Learning Objective Flow, and Learning Objectives of the Independent Curriculum. The media consists of four sets of cards based on the material's sub-chapters, complete with user instructions and flashcard, learn, match, and test features that support interactive and independent learning. The developed product was then validated and tested. To provide a clearer picture of the product being developed, the following shows digital flashcard learning media supported by Quizlet.

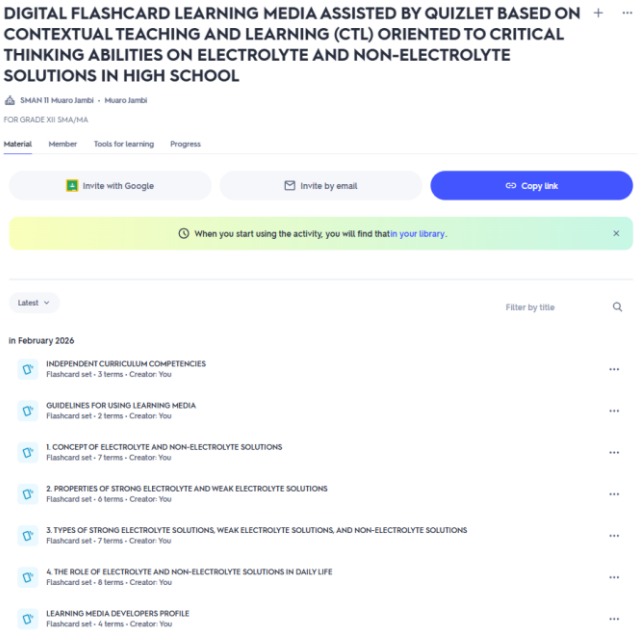

Figure 2. Initial Display of Digital Flashcard

The initial display of the media contains the title of the material, Merdeka curriculum competencies, instructions for using the media, sub-chapters of the material, and the profile of the learning media developer.

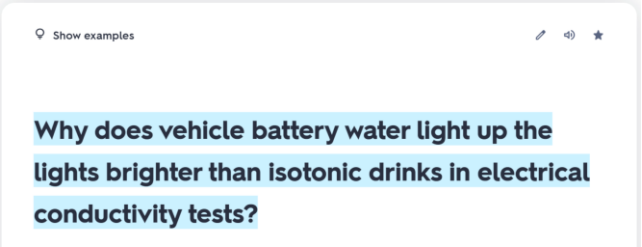

Figure 3. Flashcard Display (Questions)

This section presents questions based on everyday life contexts designed to stimulate students' critical thinking skills, in line with the CTL approach.

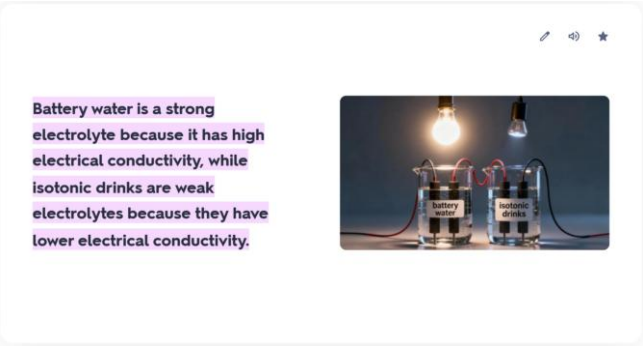

Figure 4. Flashcard Display (Statement)

The display contains answers accompanied by brief explanations to help students understand the concept independently.

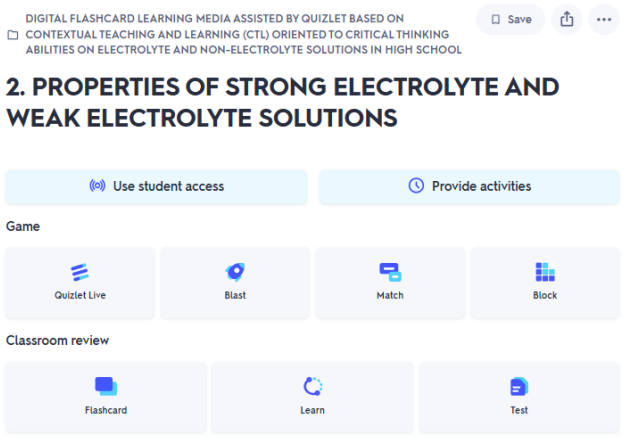

Figure 5. View of Learning Features on Quizlet

The Quizlet app offers a variety of interactive learning features, including flashcards, Learn, Match, Quizlet Live, Blast, Test, and Block, designed to support active, independent, and enjoyable learning. The flashcards feature presents material as digital cards with questions and answers that help students grasp concepts through gradual repetition. The learning feature provides adaptive exercises that adapt to students' level of understanding, allowing questions not yet mastered to be repeated automatically to reinforce understanding. The match feature is a game that involves matching pairs of questions and answers, improving students' thinking speed and memory through engaging activities. Furthermore, the Quizlet Live feature enables collaborative, group-based learning that encourages cooperation, communication, and active student engagement. The blast feature offers interactive games that train speed and accuracy in answering questions, thereby increasing focus on learning. Meanwhile, the test feature serves as an evaluation tool with various question formats and provides immediate feedback, allowing students to independently assess their understanding. Furthermore, the block feature is an interactive game that involves arranging and matching blocks. Students must match certain boxes to complete a challenge, and upon success, questions will appear for them to answer. This feature is unique because it combines game elements with evaluation, increasing student engagement, training accuracy, and encouraging critical thinking skills in a fun learning environment. The integration of these features makes the learning media not only a means of delivering material but also a means of developing students' critical thinking skills through varied and contextual learning experiences.

At this stage, all suggestions from learning experts have been revised, including the suitability of the content to the curriculum, the accuracy of the concept, the depth of the material, the language, and the integration of the CTL approach in the media, so that the content of this digital flashcard becomes clearer, more structured, and more meaningful for students. At this stage, all suggestions from learning experts have been revised. The validation results show that the material presented is in accordance with the established competencies and is suitable for use after the revision in the first stage. This is in line with research stating that contextual-based learning media is considered valid and suitable because it is able to link the material taught to students' real-world situations, thereby helping them build connections between the knowledge they have and its application in everyday life as family and community members [23].

Table 3. Results of Material Expert Validation

Assessment Aspects	Phase I	Percentage (%)	Phase II	Percentage (%)
Curriculum	3.3	82.5	4	100
Contents	3.4	85	3.7	92.5
Linguistics	3.5	87.5	4	100
Total Score	10.2	-	11.7	-
Average Score	3.4	85	3.9	97
Category		Very Worthy		

Furthermore, media expert validation aimed to assess aspects of appearance, design, readability, interactivity, and ease of use. The assessment results showed that the media had an attractive appearance, clear navigation, and features that support learning. This is supported by the use of educational multimedia with a consistent appearance and clear navigation.

Table 4. Media Expert Validation Results

Assessment Aspects	Score	Percentage (%)
Relevance to the Curriculum	4.6	92
Layout	4.3	86
Linguistics	4.6	92
Interactivity	4.5	90
Usability	4.5	90
Assessment	4.5	90
Total Score	27	-
Average Score	4.5	90%
Category		Worthy

Teacher assessments were conducted before the product was implemented with students to determine the media's suitability for classroom learning needs. The assessment results indicated that the developed media was appropriate for student characteristics and could be used to support both independent and classroom learning.

Table 5. Teacher Assessment Results

Assessment Aspects	Score	Percentage (%)
Learning materials	3.5	87.5
Learning Design	3.6	90
Assessment	4	100
Interest	3.3	82.5
Usefulness	3.6	90
Total Score	18	-
Average Score	3.6	90
Category	Very Worthy	

One-to-one trials were conducted with three students with varying academic abilities to determine the clarity of the material and ease of use of the media. Results showed

that students understood the card's contents and operated the media effectively.

Table 6. Results of One-on-One Trials

Question Number	Student A	Student B	Student C	Total Score
1.	0.5	1	1	2.5
2.	1	1	0.5	2.5
3.	1	1	1	3
4.	0.5	1	1	2.5
5.	1	0.5	0.5	2
6.	0.5	1	1	2.5
7.	1	1	1	3
8.	0.5	0.5	1	2
9.	1	1	1	3
10.	1	1	1	3
Total Score				26
Average Score				0.86
Percentage (%)				86.6%
Category				Very Good

A small-group test was conducted to determine students' responses to the media's appeal, practicality, and usefulness. Students responded positively to the use of digital flashcards assisted by Quizlet in chemistry learning. These results support the notion that critical thinking involves the ability to express opinions in an organized manner based on responses to media and structured evaluations of both personal and others' opinions [24].

Table 7. Student Response Questionnaire Results

Assessment Aspects	Total Score	Percentage (%)
Operational	34.4	86
Learning materials	34.66	86.65
Interest and Motivation to Learn	34	85
Comfort and Pleasure	35.3	88.25
Visual Communication	34.4	86
Media Benefits	34.5	86.25
Total Score	207.2	-
Average Score	34.5	86.25
Category		Very Good

The evaluation used Quizlet's test feature to provide an overview of students' critical thinking skills after using CTL-based media. The results showed that most students answered questions at a very good level, indicating the development of critical thinking skills. This evaluation was not intended to test effectiveness experimentally, but rather to describe the development of students' critical thinking skills. These results are supported by the statement that the low critical thinking skills of the students are caused by the teacher rarely applying learning that leads to critical thinking skills during the learning process, the practice questions presented still do not meet the criteria for measuring critical thinking skills, students are less actively involved in constructing knowledge in their own way, and students do not practice enough [1]. So that students' inability to think critically can be caused by teachers not emphasizing metacognitive aspects in the learning process, or the process of evaluating understanding of the material [25].

Table 8. Student Understanding Evaluation Result

No.	Sub Chapter Material				Total Percentage
	1	2	3	4	
1	71%	83%	43%	100%	74.25%
2	71%	83%	86%	75%	78.75%
3	86%	83%	57%	88%	78.75%
4	71%	83%	71%	100%	81.25%
5	86%	100%	71%	63%	80%
6	86%	100%	86%	100%	93%
7	86%	83%	71%	75%	78.75%
8	86%	100%	100%	75%	90.25%
9	86%	100%	71%	88%	86.25%
10	86%	83%	57%	100%	81.50%
Total	81.50 %	89.80%	71.30%	86.40%	82.27%
	Category				Very Good

Overall, the development results show that the digital flashcard media, assisted by Quizlet and based on a CTL-oriented approach to critical thinking skills, is highly feasible and has received very positive responses from both teachers and students. This research supports that the application of Contextual Teaching and Learning (CTL) based learning assessment is considered very valid and suitable for use because it is able to link learning with real life (concrete), so that students can more easily understand the concepts being studied [26].

Implementation Stage

The developed digital flashcard learning media, supported by Quizlet and based on Contextual Teaching and Learning (CTL), was declared conceptually and procedurally feasible through validation by subject-matter experts, media experts, and practitioner assessments. Furthermore, small-group trials demonstrated a positive student response to media use in learning, particularly in encouraging active student engagement.

Although this research did not proceed to a large-scale field trial, the developed product was ready for classroom use by teachers. During the implementation phase, researchers prepared teaching materials in the form of a Lesson Plan and an e-module on electrolyte and non-electrolyte solutions, integrated with digital flashcards and the CTL-based Quizlet. The teaching materials were structured in accordance with the Learning Outcomes and Learning Objectives in the Independent Curriculum and included systematic learning steps, from introductory activities to core activities and closing activities.

The development of Learning Implementation Plans and e-modules aims to support optimal media use, thereby providing a stimulus that encourages students' critical thinking skills through contextual learning activities. The e-modules serve as structured, independent learning resources, while the lesson plans serve as a guide for classroom learning. With these teaching tools, teachers have clear guidelines for utilizing the flashcard, learn, and test features on Quizlet, allowing the learning process to proceed in a focused manner and remain oriented toward developing students' critical thinking skills in accordance with the CTL approach.

Thus, even though the research was limited to the small-group trial stage, the developed media product was

ready for implementation in classroom chemistry instruction, supported by the prepared teaching module.

Evaluation Stage

The evaluation phase of this research aims to assess the suitability of the developed product for the initial objectives of the learning media development. The evaluation is formative and takes place at each stage: analysis, design, development, and implementation. This evaluation aims to identify and correct any deficiencies discovered during the learning media development process, thereby optimizing the resulting product.

Evaluation results using the Quizlet test feature indicate that student achievement is in the very good category. This finding indicates that integrating the Contextual Teaching and Learning (CTL) approach into digital learning media can foster students' critical thinking skills. Through the CTL approach, students not only memorize concepts but also learn to analyze, evaluate, and relate concepts to everyday life contexts, thus making the learning process more meaningful.

However, this study did not assess the effectiveness of the learning media using an experimental design, such as a pretest-posttest. Therefore, this study focused primarily on the feasibility of the media and user responses to the developed learning media. Furthermore, reliance on internet access was also a limitation in implementing Quizlet-based learning media.

Overall, the evaluation results indicate that the digital flashcard learning media, supported by Quizlet based on Contextual Teaching and Learning (CTL), have strong potential to support more interactive, contextual, and critical-thinking-oriented chemistry learning, especially for the abstract topic of electrolyte and non-electrolyte solutions. Thus, the developed learning media are considered conceptually and structurally feasible for use as an alternative chemistry learning medium in schools.

Conclusion

Based on the results of the research on the development of Quizlet-assisted digital flashcard learning media based on Contextual Teaching and Learning (CTL) for the topic of electrolyte and non-electrolyte solutions at the high school level, it can be concluded that the development process was carried out using the Lee & Owens model, which consists of analysis, design, development, implementation, and evaluation stages, with trials conducted on a limited scale through one-to-one and small-group testing. The validation results from both material experts and media experts indicate that the developed media falls into the "very feasible" category, both conceptually and procedurally, demonstrating its capability to support the learning process and provide stimuli that foster students' critical thinking skills in analyzing, evaluating, and making decisions related to electrolyte and non-electrolyte solution concepts, in alignment with the established learning objectives. Furthermore, teachers' assessments categorized the media as "very adequate," particularly in terms of the completeness of learning materials, the ease of use of the Quizlet platform, and the relevance of CTL-based activities. In addition, students' responses were classified as "very good," reflecting increased interest, motivation, engagement, and overall support in enhancing their understanding during the learning process.

Author's Contribution

R.D.M. Manalu: contributed as the main author and developer of learning media, playing a role in research design, the development of digital flashcard media using CTL-based Quizlet, and the preparation of article manuscripts, with a focus on students' critical thinking skills, data collection and analysis. W. Syahri & M.H.E Hasibuan: contributed as the author's research supervisors who provided direction in research design, media development process, as well as review and improvement of the manuscript. Haryanto: contributed as a materials expert validator, conducting assessments and providing input on the suitability and depth of the developed learning materials to ensure they were suitable for use. Zurweni: contributed as a media expert validator, providing assessments and suggestions for improvements in the design, appearance, and feasibility of the developed learning media, ensuring they were suitable for use in and out of the classroom.

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