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Development of Intertextual-Based Learning Videos on Corrosion Concept

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***Abstract*:** *This study aimed to develop and evaluate an intertextual-based instructional video on the topic of corrosion by integrating macroscopic, submicroscopic, and symbolic representations within a constructivist multimedia framework. The development followed the ADDIE model through five stages: analysis, design, development, implementation, and evaluation. The video, divided into three segments—corrosion process, prevention methods, and influencing factors—was validated by experts in content, pedagogy, and media. Validation results showed high feasibility with scores of 84.2% (content), 93.75% (pedagogy), and 88.86% (media), all categorized as "Very Good." Teacher responses averaged 97.29%, while student responses reached 100%, indicating excellent clarity, contextual relevance, and engagement. Minor revisions related to narration and animation sequencing were implemented based on expert feedback. The main innovation of this study lies in combining intertextual contexts with multilevel chemical representations to make abstract electrochemical processes more accessible. The developed video is feasible for use as a teaching aid in electrochemistry and has potential for adaptation to other chemistry topics requiring multiple representations.*

***Keywords*:** *Intertextual-based learning; corrosion; chemical representations; instructional video; chemistry education*

INTRODUCTION

Corrosion is a natural process that causes the gradual degradation of metals, through chemical interactions with their surrounding environment. This phenomenon poses serious global challenges: it leads to enormous economic losses—estimated at around 10% of total metal production each year—and affects critical sectors such as manufacturing, construction, and oil industries (Fayomi et al., 2019). Beyond its economic impact, corrosion also threatens infrastructure safety, environmental quality, and the sustainability of technological systems.

Given these wide-ranging effects, understanding corrosion is not only scientifically important but also socially and economically relevant. Therefore, chemistry education should help students comprehend the underlying processes of corrosion so that they can connect scientific principles with real-world problems and contribute to mitigating its impact. However, students often face difficulties in explaining corrosion scientifically. While they can easily recognize rust on water taps, fences, or vehicles, they rarely understand the submicroscopic and symbolic processes involved. Many fail to connect the macroscopic appearance of rust to the underlying electron transfer, ion movement, and redox reactions (Nugrohadi & Chasanah, 2022; Nisa & Fitriza, 2021).

To overcome these learning challenges, instructional media that incorporate multimodal representations can be useful. The theory of multimedia learning indicates that integrating visual and auditory channels supports better mental model construction of abstract processes (Mayer, 2021). In the context of chemistry education, videos can support students' cognitive, affective, and psychomotor domains by illustrating otherwise invisible processes, such as electron movement or oxidation-reduction reactions (Lalian, 2018; Puspitarini & Hanif, 2019). Studies have shown that well-designed instructional videos can improve conceptual understanding in topics such as entropy and reaction rates (Ramachandran et al., 2019; Wildaiman et al., 2022), and outperform traditional teaching methods in enhancing student performance (Bohloko et al., 2019). Recent research also demonstrates that video-based learning in chemistry improves student attitude, engagement and academic performance (Adjei et al., 2024). Moreover, when video media are designed using constructivist and inquiry-based approaches, students engage more actively, explore concepts, and develop deeper understanding (Suryati et al., 2024). In addition, intertextuality—linking chemistry concepts to everyday contexts, social issues or cultural narratives—has gained recognition in chemistry education for promoting meaningful learning and transfer of knowledge (A'qidah & Rahmawan, 2024).

Although prior studies have demonstrated the benefits of video-based learning, constructivist pedagogy and representation theory separately, few have combined these approaches in a coherent instructional video design that explicitly addresses three levels of chemical representation and real-world context. The innovative aspect of this study lies in the integration of intertextual context, three-level representation, and constructivist multimedia design within a single instructional video. Specifically, the topic of corrosion—characterised by electrochemical processes and the linkage of macroscopic corrosion phenomena to submicroscopic and symbolic levels—remains under-explored in this media design context. This integration represents a novel contribution that distinguishes this study from previous video-based learning research. Therefore, this study aims to develop an intertextual-based instructional video on the concept of corrosion that integrates macroscopic, submicroscopic and symbolic representations within a constructivist framework, and to evaluate its feasibility (validation by experts, and responses of teachers and students) in supporting students' understanding of the corrosion concept. It is hypothesised that such integration will enhance students' conceptual understanding of corrosion and reduce their misconceptions.

LITERATURE REVIEW

Challenges in Learning the Concept of Corrosion

Understanding corrosion requires students to navigate across the three levels of chemical representation: the macroscopic (observable rusting), submicroscopic (particle/ion interactions, electron transfer) and symbolic (equations, reaction representations). Students frequently struggle to link these levels; for example, they may memorise the equation for iron oxidation but fail to connect it to rust formation or ion migration (Hatimah & Khery, 2021; Rahayu et al., 2023). This difficulty is consistent with Silitonga and Muchtar (2023), who noted that most chemistry concepts inherently involve macroscopic, submicroscopic, and symbolic representations, making them particularly challenging for students to grasp. Moreover, the use of inappropriate teaching models often contributes to students' difficulty in constructing accurate mental models of chemical processes (Fadli et al., 2025). Recent work by Rizal et al. (2024) emphasises that this disconnect remains a significant barrier in chemistry education. The intertextual-based e-book prototype study by Dewi et al. (2024) further confirmed that when students cannot link the three levels, their conceptual understanding remains low ($N_{gain} = 0{,}44 - 0{,}48$). Given these difficulties, instructional design in chemistry must explicitly support transitions across representations and provide relevant contextual links.

Video-Based Learning in Chemistry

Video-based media offer rich opportunities for multimodal representation by combining visual and auditory channels, animations, real-life footage, and interactive elements. Such media can make abstract chemical processes more accessible and support students' understanding through simultaneous sensory engagement. Animated videos, in particular, can assist learners in comprehending abstract concepts through the integration of appealing visuals and narration (Sarina et al., 2024). Similarly, Tambunan et al. (2024) emphasized that video media effectively help educators deliver materials that are otherwise difficult to explain using conventional methods. Herrington and Sweeder (2025) proposed a framework for designing chemistry instructional videos that foster conceptual understanding by emphasising causal mechanistic reasoning and aligning with multimedia learning principles. Similarly, Adjei et al. (2024) found that YouTube-assisted instruction significantly improved pre-service teachers' attitudes and academic performance in chemistry. In another study, Sumanik et al. (2024) developed and validated a YouTube-integrated interactive video on green chemistry, which was found effective for enhancing students' comprehension. More broadly, Trianisa and Wahyuni (2024) reported that YouTube-based science learning in secondary schools led to significantly improved learning outcomes compared to traditional instruction.

Collectively, these studies highlight the effectiveness of video-based learning in enhancing engagement, attitudes, and conceptual understanding in chemistry education. However, most existing videos still emphasise either macroscopic demonstrations or symbolic equations, with limited attention to submicroscopic representations or contextual (intertextual) connections. This indicates a need for instructional media that not only present multiple representations, but also situate them within meaningful real-world contexts to promote deeper conceptual understanding—particularly for complex topics such as corrosion.

Constructivist and Inquiry-Based Learning Approaches

Constructivist pedagogy emphasises that learners actively build knowledge by integrating new information with prior experiences and by reflecting and problem-solving. Inquiry-based learning (IBL) further supports this by engaging students in exploring questions, conducting investigations and drawing conclusions. Suryati et al. (2024) conducted a systematic review of 30 peer-reviewed articles and found that the integration of constructivist and IBL strategies in chemistry education enhances engagement, conceptual understanding, critical thinking and problem-solving skills. When instructional videos are designed using these principles, media becomes not just passive viewing but interactive environments for knowledge construction.

Multiple Representations in Chemistry Learning

The use of macroscopic, submicroscopic and symbolic representations is foundational in chemistry education because each level contributes uniquely to a comprehensive understanding of chemical phenomena. Uleng et al. (2024) state that a primary student difficulty is linking these three levels—macroscopic, submicroscopic, and symbolic—which underlies incomplete mental models. They concluded that most student mental models remain alternative or incomplete because of weak inter-level connections. Similarly, Hamerská et al. (2024) emphasise that conceptual understanding in chemistry is only achieved when students are able to integrate the three levels simultaneously and use dynamic visual media to bridge them. This suggests that instructional materials must specifically support representation bridging, rather than treating each level in isolation. Although many prior studies address representation or context separately, they seldom integrate all three levels in one media product.

METHODS

This study employed a development research design using the ADDIE model (Analyze, Design, Development, Implementation, Evaluation) model as shown in Figure 1 to produce an intertextual-based learning video about corrosion and evaluate its feasibility.

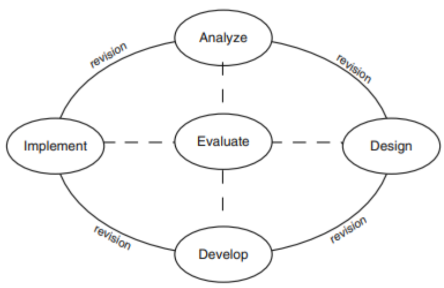

Figure 1. ADDIE Model Stages (Branch, 2010)

The ADDIE model offers a structured framework suitable for designing effective educational media (Branch, 2010).

Analysis Phase

The analysis stage involved several activities: (1) curriculum analysis to identify core corrosion concepts, (2) analysis of the three chemical representation levels (macroscopic, submicroscopic, and symbolic), (3) analysis of students' common misconceptions from prior studies, and (4) content review of corrosion-related instructional videos on YouTube. The existing videos were examined for their strengths and weaknesses in content accuracy, pedagogical clarity, and multimedia presentation.

Design Phase

Data from the analysis informed the design of the instructional video. Selected subtopics included corrosion processes, prevention strategies, and factors accelerating corrosion. Representation selection followed General Chemistry textbook analysis to align with conceptual labels. A script and storyboard were developed, detailing narration and animation elements that connect the three representation levels. Animations included visualizations of electron flow and ionic interactions in rust formation.

Development Phase

Video development was carried out using Capcut for recording and editing, Adobe After Effects for animation, and Canva for additional visuals. The media was designed to integrate real-world contexts (intertextual elements) with synchronized representations. Upon completion, the video was validated by experts in content, pedagogy, and media using structured instruments. Feedback was collected for product revision.

Implementation Phase

The revised video was tested through a limited implementation involving two chemistry teachers and ten students. The purpose was to assess clarity, alignment with objectives, and media appeal before broader application.

Evaluation Phase

Formative evaluation was conducted using teacher and student feedback questionnaires. Comments and responses were used to refine the video for future instructional use.

Participants and Validators

This study involved three expert validators, two chemistry teachers, and ten students in the limited implementation stage. The expert validators consisted of (1) a chemistry education lecturer serving as the content expert, (2) an instructional design specialist as the pedagogical expert, and (3) a multimedia learning specialist as the media expert. Meanwhile, the two chemistry teachers were selected based on their teaching experience of more than five years and familiarity with the corrosion topic. The ten students who participated were from a senior high school and had studied the basic concept of redox reactions, which underlie the corrosion process.

Instruments

The experts assessed the developed video product using structured validation instruments, while teachers and students provided responses on its clarity, usefulness, and visual appeal during limited implementation. The validation instruments were constructed based on theoretical and practical aspects relevant to chemistry learning media. Each instrument comprised indicators covering content, pedagogy, and media aspects. The details of these aspects are presented in Table 1.

Table 1. Validation Instrument Indicators

Aspect	Indicator	Number of Items
Content	• Accuracy • Conceptual clarity • Linkage between representations	19
Pedagogy	• Constructivist principles • Misconception prevention	13
Media	• Consistency with Mayer's Multimedia Learning Principles • Typography • Visual quality	18

In addition to expert validation, teachers and students were involved to evaluate the clarity, usefulness, and visual appeal of the instructional video. Their responses were collected using structured questionnaires based on the Guttman scale ("Yes" = 1, "No" = 0). Teacher and student response indicators are shown in Table 2 and Table 3, respectively

Table 2. Teacher Response Indicators

Category	Indicator
Content	• Concept accuracy • Relevance • Clarity
Pedagogy	• Logical sequence • Constructivist orientation • Misconception prevention
Media	• Audio-visual clarity • Synchronization • Visual appeal
Role of Video	• Usefulness • Applicability • Teaching potential

Table 3. Student Response Indicators

Category	Indicator
Motivation	• Interest • Engagement • Contextual relevance
Content Understanding	• Comprehension of process, prevention, and influencing factors
Visualization and Interactivity	• Visual coherence • Animation relevance • Interactivity
Video display	• Clarity • Narration quality • Absence of distractions

Data Analysis

Expert review results were analyzed qualitatively using the Miles and Huberman model (Sugiyono, 2017), which includes:

(1) Data condensation, where comments were grouped based on the three evaluated aspects.
(2) Data display, organizing inputs into clear visual summaries.
(3) Conclusion drawing and verification, identifying areas for improvement and final product decisions.

Student and teacher responses were quantified using the Guttman scale (Yes = 1, No = 0). The percentage of agreement was calculated by comparing the total score obtained with the ideal score. Interpretation followed Riduwan's (2010) criteria:

- 0–20% = Not Good
- 21–40% = Poor
- 41–60% = Fair
- 61–80% = Good
- 81–100% = Very Good

RESULT AND DISCUSSION

This study aimed to develop and evaluate an intertextual-based instructional video on the topic of corrosion. The evaluation focused on three main aspects—content, pedagogy, and media—through expert validation, followed by feedback from teachers and students during limited implementation. Quantitative and qualitative analyses were conducted to determine the feasibility of the product.

It was assumed that the intertextual-based video would enhance students' conceptual understanding of corrosion and minimize misconceptions by integrating the three levels of chemical representation: macroscopic, submicroscopic, and symbolic. The expert validation results are presented as percentages of agreement, categorized according to Riduwan's (2010) criteria (Very Good, Good, etc.), while teacher and student responses were analyzed descriptively using percentage scores and visualized in graphs for clarity as shown in Figure 4.

Overall, the findings demonstrated that the video achieved high validity across all evaluated aspects and received positive responses from teachers and students. The following sections discuss the expert validation results, user feedback, and educational implications in detail.

Expert Evaluation Results

1. Content Aspect

The scientific accuracy and representational quality of the video content were evaluated by two chemistry education experts. Emphasis was placed on accuracy, conceptual clarity, and linkage between representations. These levels are crucial for promoting meaningful chemical understanding and avoiding misconceptions (Qian et al., 2023).

Based on expert validation, 16 out of 19 indicators were rated "Yes," resulting in a content validity percentage of 84.2%, which falls under the "Very Good" category according to Riduwan's (2010) interpretation. This indicates that the video content is accurate, coherent, and appropriately linked across the three levels of chemical representation.

As shown in Table 4, the video obtained high scores on conceptual accuracy and representation linkage, while experts suggested slight refinements to visualization and terminological clarity.

Table 4. Content Validation Results

Aspect	Number of Items	Yes Responses	Percentage (%)	Category
Content (Accuracy, Clarity, Linkage)	19	16	84.2%	Very Good

Experts confirmed that the scientific accuracy of the video was consistent with the high school chemistry curriculum, particularly regarding redox processes, electrochemical mechanisms, and corrosion prevention. The conceptual flow followed the corrosion phenomena logically—from observation of rusting to electrochemical explanation—facilitating representational understanding.

One suggestion from experts was to refine the visualization of $Fe(OH)_3$ formation to show its stability as a precipitate, and to clarify electron transfer by referencing the standard reduction potential table. Figures 2 and 3 illustrate these visual elements.

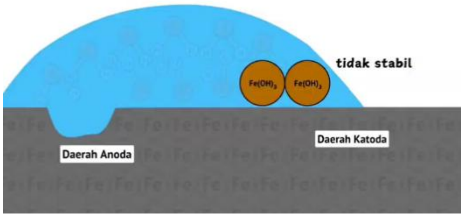

Figure 2. Visualization of $Fe(OH)_3$ Formation

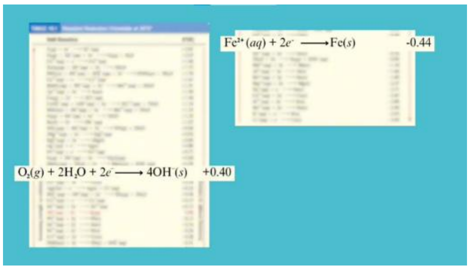

Figure 3. Standard Reduction Potential Table in the Video

The macroscopic level was illustrated with familiar corrosion phenomena, such as rusted fences and nails, which served as contextual entry points in the media. The submicroscopic level showed animations of Fe^{2+} formation and electron flow, using color-coded ions and synchronized narration for clarity. Symbolic representations were delivered through step-by-step redox equations. This triple integration of macroscopic, submicroscopic, and symbolic levels—commonly referred to as Johnstone's triangle—enabled students to connect observable changes, particle behavior, and symbolic meaning, a key element in fostering conceptual understanding (Getu et al., 2024)

Compared to typical YouTube-style chemistry videos, the developed product displayed stronger intertextual and contextual integration between real-world examples and theoretical constructs. Similar to Pekdağ's (2020) conclusion that contextualized multimedia supports representational learning, the media effectively integrated real-world and symbolic representations to reduce misconceptions in electrochemistry.

In summary, the content aspect achieved a Very Good level of validity, confirming that the video meets scientific accuracy, conceptual clarity, and representational integration criteria after minor revisions.

2. Pedagogical Aspect

The pedagogical aspect focused on how the developed video applied constructivist learning principles and prevented misconceptions. As shown in Table 5, 12 out of 13 items (92.31%) were rated "Yes," indicating that the video met most pedagogical criteria with a Very Good category.

Table 5. Pedagogy Validation Results

Aspect	Number of Items	Yes Responses	Percentage (%)	Category
Constructivist principles	8	7	87.5%	Very Good
Misconception prevention	5	5	100%	Very Good
Average	**13**	**12**	**93.75%**	**Very Good**

The video demonstrated strong constructivist characteristics through contextual exploration, reflective questioning, and progressive concept elaboration. The learning sequence—from familiar macroscopic corrosion phenomena to abstract submicroscopic explanations—facilitated cognitive scaffolding and minimized cognitive load, aligning with Mayer's (2021) multimedia principles. Presenting concrete, observable contexts before introducing symbolic and submicroscopic representations enabled more meaningful conceptual links, consistent with Tal et al. (2021), who found that context-based chemistry learning strengthens the ability to relate scientific principles to real-world situations.

Inquiry and constructivist elements were embedded through guiding questions, explanation, and reflection activities that supported an inquiry cycle of observation–explanation–application. This approach aligns with Suryati et al. (2024), who reported that constructivist and inquiry-based video learning enhances conceptual understanding and critical thinking in chemistry. The expert also highlighted the integration of real-life corrosion contexts as a key factor in promoting motivation and meaningful learning. Minor revisions—such as adding bridging narration and refining transition flow—further improved conceptual coherence. Overall, the video's pedagogical structure effectively supports student-centered and context-based chemistry learning, reducing misconceptions and fostering deeper understanding.

3. Media Aspect

The media aspect of the instructional video was evaluated based on Mayer's (2021) multimedia learning principles, including coherence, signaling, spatial and temporal contiguity, and modality. These principles aim to optimize information processing by reducing extraneous cognitive load and enhancing visual-verbal integration. As shown in Table 6, 17 out of 18 items (94.44%) received a "Yes" rating, indicating a Very Good level of feasibility.

Table 6. Media Validation Results

Aspect	Number of Items	Yes Responses	Percentage (%)	Category
Consistency with Mayer's Multimedia Learning Principles	12	12	100%	Very Good
Typography	3	2	66.6%	Good
Visual quality	3	3	100%	Very Good
Average	**18**	**17**	**88.86%**	**Very Good**

The expert noted that the video demonstrated strong visual clarity and effective signaling, particularly in the submicroscopic animations of electron transfer and ion movement. The color contrast between Fe^{2+} ions and electrons, combined with synchronized narration, directed students' attention toward key transitions. This design aligns with Mayer's (2021) signaling and coherence principles, which emphasize highlighting relevant information and removing extraneous details to minimize cognitive overload.

The synchronized narration and animation timing facilitated integration of visual and auditory information, consistent with Getu et al. (2024), who reported that synchronized media enhance conceptual understanding of electrochemical processes. Compared with typical chemistry videos focusing only on macroscopic demonstrations, the media provided integrated transitions among macroscopic, submicroscopic, and symbolic representations. This integration supports more meaningful visualization of particle-level processes, echoing findings by Sumanik et al. (2024) that dynamic visualizations improve student engagement and conceptual understanding in chemistry learning.

Minor adjustments, such as refining animation transitions and ensuring consistent typography, were implemented to maintain visual continuity and professional quality. Overall, the media component was rated highly feasible and effective, balancing visual aesthetics with conceptual clarity while reducing cognitive load.

Teacher Responses

Teacher evaluations were conducted to complement expert validation and assess the instructional video's classroom applicability from a practitioner's perspective. Two chemistry teachers participated, each with more than five years of teaching experience and familiarity with the corrosion topic. The evaluation covered four main aspects: content, pedagogy, media, and the role of the video in instruction.

As shown in Table 7, both teachers responded positively to nearly all items. Out of 24 statements, Teacher 1 answered "Yes" to 23 items (95.83%) and Teacher 2 answered "Yes" to 24 items (100%). The average agreement rate of 97.92% indicates that the video meets the Very Good category.

Table 7. Teacher Response Results

Aspect	Teacher 1 (%)	Teacher 2 (%)	Average (%)	Category
Content	100%	100%	100%	Very Good
Pedagogy	100%	100%	100%	Good
Media	100%	100%	100%	Very Good
Role of video	66.67%	100%	83.33%	Good
Overall Average	**95.83%**	**100%**	**97.92%**	**Very Good**

The data suggest that teachers found the video highly suitable for explaining corrosion phenomena in class. They particularly appreciated the clarity of narration and visuals, which simplified abstract redox processes such as ion migration and electron transfer. The constructivist sequence—moving from concrete to abstract—was noted as pedagogically strong, aligning with the principle of scaffolding emphasized in Suryati et al. (2024).

In addition, teachers recognized that the integration of macroscopic, submicroscopic, and symbolic representations successfully supported students' conceptual understanding, consistent with the findings of Getu et al. (2024). One minor suggestion concerned the "role of the video" aspect, where teachers noted that while the video was highly effective as an introductory and explanatory tool, it would be even more powerful when combined with teacher-guided discussions or simple demonstrations to reinforce student inquiry.

These findings align with previous studies (Adjei et al., 2024; Sumanik et al., 2024), which highlight that video-based chemistry learning enhances motivation and comprehension when integrated with active classroom interaction. The teachers' evaluations thus confirmed the practicality and pedagogical soundness of the media as a classroom learning aid.

Student Responses

Student feedback provided additional evidence on the clarity, engagement, and conceptual impact of the developed intertextual-based learning video. Ten students participated in the limited implementation and all students responded positively (Yes) to every statement, resulting in 100% agreement across all indicators as shown in Table 8. According to Riduwan's (2010) criteria, this score falls into the Very Good category, indicating that the products met the expected standards of clarity, usefulness, and engagement from the learners' perspective.

Table 8. Student Response Results

Aspect	Number of Items	Percentage of "Yes" (%)	Category
Motivation	2	100%	Very Good
Content Understanding	4	100%	Good
Visualization and Interactivity	4	100%	Very Good
Video display	6	100%	Very Good
Overall Average	**16**	**100%**	**Very Good**

Students perceived the video as motivating and easy to follow, highlighting that the use of animation and real-life contexts made corrosion processes more understandable. They also emphasized that the questions embedded in the video encouraged active thinking and reflection. These findings are consistent with Adjei et al. (2024), who reported that YouTube-based chemistry videos increase student engagement and positive attitudes toward learning science.

A graphical comparison between teacher and student responses is presented in Figure 4. The figure shows that both groups rated the video very positively, with average agreement levels above 95%. Because the validation for each aspect involved a single expert and both teacher and student responses were highly consistent (mostly 100% "Yes" answers), standard deviation or variance analysis was not conducted. The data thus represent stable agreement levels across evaluators.

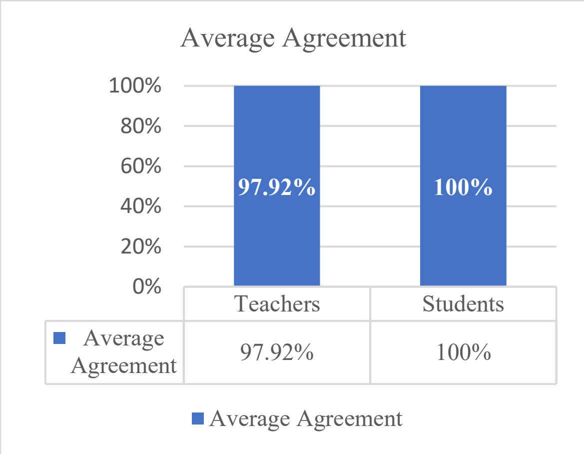

Figure 4. Teachers' and Students' Agreement

These findings are further discussed in relation to previous studies in the following section.

The integration of video in learning activities contributes not only to improving conceptual understanding but also to increasing students' motivation and engagement. Well-designed educational videos can make learning materials more accessible and enjoyable, helping students to grasp complex ideas without feeling overwhelmed (Sembiring & Susanti, 2023).

Overall, the validation outcomes and user feedback demonstrate that the intertextual-based learning video on corrosion achieved high feasibility across content, pedagogical, and media aspects, supported by strong positive responses from teachers and students. These results confirm the initial assumption that integrating real-world contexts with the three levels of chemical representation enhances conceptual understanding and reduces misconceptions in electrochemical topics. This finding is consistent with prior studies showing that chemistry learning becomes more meaningful when students connect observable phenomena to abstract models and symbolic representations (Ryu et al., 2018; Herrington & Sweeder, 2025).

The developed video successfully demonstrated the integration of macroscopic, submicroscopic, and symbolic representations, in line with Johnstone's framework. Such representational linkage supports deeper conceptual understanding and prevents fragmented learning, as emphasized by Herrington and Sweeder (2025). Furthermore, the intertextual design of the video facilitated representational translation by embedding everyday corrosion phenomena within theoretical explanations. This supports the findings of Ryu et al. (2018), who reported that context-based or intertextual chemistry learning allows students to relate daily experiences to abstract scientific concepts, thereby strengthening conceptual coherence and chemical literacy. Similarly, Nabila et al. (2024) found that contextual modules integrating multiple representations improved students' ability to connect macroscopic observations with submicroscopic reasoning and symbolic comprehension.

These parallels indicate that the developed intertextual video not only conveys content accurately but also operationalizes representational integration as a learning mechanism. By visualizing molecular processes and aligning narration with equations, the video helped bridge symbolic abstraction and tangible phenomena, an outcome often difficult to achieve through textbook-based instruction alone.

The pedagogical and media validation results underscore that the video effectively applied constructivist principles supported by multimedia learning theory. The constructivist design encouraged learners to build understanding through exploration, guided questioning, and reflection—processes that align with von Glasersfeld's (as cited in Sasan & Rabillas, 2022) view that learning involves constructing conceptual frameworks through active reasoning. Similarly, Bada (as cited in Sasan & Rabillas, 2022) emphasizes that cognition results from integrating new information with prior knowledge, a principle evident in the video's sequence from familiar corrosion examples to submicroscopic explanations.

From a multimedia learning perspective, the integration of narration, animation, and text followed Mayer's principles of coherence, signaling, and temporal contiguity. This alignment reduces extraneous cognitive load and supports deeper understanding, as shown by the very high media validation score. Such design aligns with Kahsay et al. (2024), who found that audiovisual resources not only enhance conceptual understanding but also promote engagement and inquiry-based learning.

The novelty of this study lies in the integration of intertextual learning contexts, three-level chemical representations, and constructivist multimedia design within a single instructional video. Unlike most existing chemistry videos that present these representations separately, this study combines them cohesively through synchronized narration, contextual visualization, and symbolic explanation, offering a new model for promoting representational coherence and conceptual understanding in electrochemistry learning.

The dynamic interaction between multimedia elements and constructivist sequencing created a system where learners could observe, interpret, and apply new knowledge in meaningful contexts. As Sasan and Rabillas (2022) stated, the application of theory to instructional tools transforms teaching into a reciprocal process of learning and meaning-making. This synthesis of design and theory explains why teachers perceived the video as pedagogically sound and supportive of classroom instruction.

The overwhelmingly positive responses from teachers and students further validate the feasibility and educational potential of the video. Teachers highlighted that the video's structure supported cognitive scaffolding, consistent with constructivist pedagogy (Suryati et al., 2024). They also recognized the video's practicality for classroom use, particularly as an introductory and explanatory medium for electrochemical topics.

Students, meanwhile, found the video motivating and engaging, noting that animations and contextual examples helped them visualize corrosion processes more clearly. This aligns with findings by Naimah (2022) that video media can simplify complex concepts and enhance learning outcomes in science education. Similarly, Mahbub et al. (2024) and Alhashem & Alfailakawi (2023) reported that integrating technology and virtual simulations in chemistry fosters interaction, curiosity, and conceptual understanding—key indicators of 21st-century learning readiness.

The combination of teacher and student perspectives suggests that the video supports both instructional and learner-centered goals: teachers benefit from a flexible and illustrative resource, while students experience deeper engagement and improved conceptual grasp. This balance is crucial for fostering self-regulated and inquiry-driven learning environments.

Educational Implications

The findings carry several implications for chemistry education and curriculum development. First, integrating intertextual and representational approaches can be a powerful strategy in the Merdeka Curriculum, which emphasizes contextual and inquiry-based learning. By connecting chemical principles to real-world issues, such as corrosion in everyday materials, the video promotes scientific literacy and relevance.

Second, this study demonstrates that video-based media can operationalize constructivist and multimodal learning simultaneously, providing teachers with pedagogically grounded digital tools. Such media are particularly useful for abstract chemistry topics like electrochemistry, thermodynamics, or reaction kinetics, where visualization supports comprehension. Lastly, future development should explore broader classroom trials, integrating interactive features such as formative assessments or embedded reflection prompts to further enhance learning engagement.

CONCLUSION

This study developed and evaluated an intertextual-based instructional video on the topic of corrosion, integrating macroscopic, submicroscopic, and symbolic representations through a constructivist and multimedia learning framework. The validation results indicated that the video met high standards in content, pedagogy, and media feasibility, while teachers and students expressed very positive responses regarding its clarity, contextual relevance, and usefulness in supporting conceptual understanding.

Theoretically, this study contributes to chemistry education by demonstrating how intertextuality—linking real-world contexts with three-level chemical representations—can operationalize meaningful learning and reduce misconceptions in abstract topics such as corrosion. Practically, it offers a validated model of digital learning media that aligns with the Merdeka Curriculum and can assist teachers in implementing context-based and inquiry-oriented instruction.

The main novelty of this work lies in its integration of intertextual context, representational coherence, and constructivist multimedia design within a single learning video framework. This model bridges representational and contextual gaps often found in conventional chemistry instruction.

However, the study was limited to small-scale validation and user responses without classroom-based implementation. Future studies should conduct broader trials to evaluate the video's impact on students' conceptual understanding, retention, and engagement across diverse learning environments. The developed intertextual video model also holds potential for adaptation to other chemistry topics that require representational fluency, such as electrolysis, equilibrium, and reaction kinetics.

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