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A Low-Barrier Approach to Developing Validated Chemistry Animations the Case of Chemical Bonding and Canva

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Abstract: Chemistry education still faces serious challenges in integrating three levels of representation, namely macroscopic, microscopic, and symbolic. This difficulty becomes more complex in abstract topics such as chemical bonding, which requires students to relate real phenomena to invisible molecular processes and formal chemical symbols. Conventional learning media tend to be static, making them less capable of depicting particle dynamics, which ultimately leads to conceptual misunderstandings. This study aims to develop and validate animation-based learning media as an innovative solution to bridge these limitations. The method used is Design-Based Research (DBR) with a 4D development model (Define, Design, Develop, Disseminate). The research subjects involved a panel of experts consisting of material, language, and media validators, as well as 35 tenth-grade students at MAN 3 Pontianak. The validation results showed a high level of reliability with Aiken scores of 93% (material), 91% (language), and 87% (media), respectively. The classroom feasibility test obtained an average score of 90%, which is classified as "very good." Thus, the animated video developed using the Canva application proved to be effective, affordable, and provided a systematic framework that can be replicated to teach abstract chemistry concepts more comprehensively.

Keyword: Canva; Chemical Bonding; Chemistry Animation; Learning Media; Media Validation

Introduction

Chemistry education faces complex challenges, particularly in its efforts to equip students with an understanding of chemical phenomena through three interconnected levels of representation (Zikri & Handayani, 2024). These representations include macroscopic aspects that emphasize directly observable phenomena, microscopic aspects that describe particle interactions on a submicroscopic scale, and symbolic aspects that are manifested through the use of symbols, formulas, and chemical equations (Firda & Lutfi 2025; Syahrial & Winarni 2021; Wiyarsi et al. 2019; Zuraini et al., 2020).

Connecting these three aspects in the chemistry learning process is not an easy task. This difficulty is often one of the main reasons why many students experience obstacles in understanding chemistry material, especially because chemistry material tends to be abstract and difficult to visualize without the help of media or the right learning approach (Sundami & Azhar, 2019)

In high school chemistry, one of the most important topics to learn is chemical bonding, because this topic is fundamental to understanding how atoms interact and form compounds, as well as how these interactions affect the properties of substances (Husni, 2022). This topic is not only abstract and difficult to understand directly, but also requires a deep understanding of a

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number of interrelated basic concepts that form an important foundation for understanding chemistry as a whole (Masayu & Risa, 2019; Nugroho & Prayitno, 2021).

One of particular reason why students struggle for chemical bonding is a strong dependency on traditional teaching media, such as textbook diagrams and lecture slides, which are often inadequate for illustrating the dynamic, three-dimensional processes that occur at the molecular level (Gultom et al., 2023; Muskhir et al., 2024)

Educational technology offers a variety of highly effective solutions to address gaps in the representation of abstract concepts, thereby helping students understand the material more easily and deeply. (Ananda et al., 2024; Karim et al., 2025), Specifically, animated videos provide a dynamic medium that can make abstract concepts more concrete and comprehensible (Purnama et al., 2024).

Animations can effectively depict the movement and interaction of electrons and atoms, helping students build accurate mental models of chemical bonding processes and fostering greater engagement and motivation (Ummahati & Suprihatiningrum, 2024)

Although animation has long been recognized as a highly effective educational medium for delivering learning materials, the practical ability to independently create high-quality animations remains very limited. This is due to the limited technical expertise of many educators and students, as well as the need for sophisticated and often expensive software (Karuana et al., 2023; Pageno et al., 2024; Setyaningsih, 2023)

Web-based design tools such as Canva have greatly reduced this barrier. Canva's user -friendly interfaces and wide library of templates and design elements empower teachers to develop visually attractive and interactive teaching materials, including animated videos, without the need for special training to teachers (Astuti, 2021; Diniyati & Mastoah, 2024; Harahap & Rahmawati, 2024; Rahmatullah et al., 2020)

This technological development provides teachers with a valuable opportunity to design and develop their own learning materials. This makes it easier for teachers to tailor learning content to the needs and unique characteristics of their students (Haleem et al., 2022; Melani et al., 2024; Utami et al., 2017), however, even though the use of platforms such as Canva in education is becoming more widespread and the benefits of video animation in the learning process have been widely proven, there is still a significant gap in the academic literature on this topic (Hilmiyati et al., 2024; Ni'mah, 2024)

There is a lack of research that documents the systematic development and rigorous validation of educator-created animated media for complex scientific topics within specific secondary school contexts. Many studies report on the use of such tools, but few provide a transparent and replicable R&D process that can guide other practitioners.

This study addresses this gap by detailing a research and development project, structured by the 4D model (Define, Design, Develop, and Disseminate), to create and evaluate a Canva-based animated video for teaching chemical bonding in an Indonesian senior high school.

The aim is not only to produce a learning medium that is validated for its content and confirmed as practical for classroom use but also to contribute a clear framework that other educators can adapt to solve similar pedagogical challenges in their own classrooms.

Method

This study uses the Design-Based Research (DBR) methodology as the main approach to develop and evaluate animated videos specifically designed for teaching chemical bonding. DBR is an iterative approach that is ideal for creating and refining educational interventions directly in authentic classroom contexts, while also contributing significantly to the development of learning theory (Astuti, 2021; Tanjung & Faiza, 2019).

In its implementation, this research process follows the four phases of Thiagarajan's 4D model, namely Define, Design, Develop, and Disseminate, which provide a systematic and structured framework for effectively executing the DBR cycle.

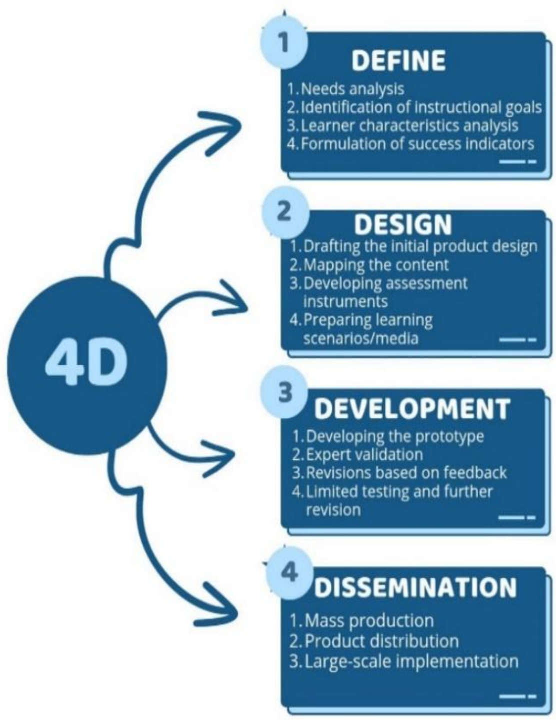

Figure 1. 4D Thiagarajan Models

Research Setting and Participants

The research was conducted at MAN 3 Pontianak, an Islamic senior high school in Indonesia. Participants were selected for two distinct phases of the study, including expert validation panel and student practicality trial. For expert validation panel, a panel of six experts was purposefully selected to validate the learning media and associated instruments.

The panel comprised two language experts, two subject matter experts in chemistry, one media design expert, and one senior high school chemistry teacher. For student practicality trial**, t**he participants for the practicality assessment were 35 students from a single class (X C) at MAN 3 Pontianak.

Researh Procedur

Define Phase

The initial phase focused on problem identification and needs analysis. Data were collected through semi-structured interviews with two chemistry teachers at the research site to understand the existing pedagogical challenges, the learning media currently in use (e.g., PowerPoint, textbooks), and their limitations in teaching abstract concepts like chemical bonding. This analysis confirmed the need for a more dynamic and visually engaging learning resource to address reported low student motivation and boredom with traditional lecture methods.

Design Phase

In this phase, the blueprint was made for educational intervention. Depending on the needs identified in the defined phase, an animated video was chosen as a target medium, canva selected as a design platform due to its access and user -friendly features. Major activities included compiling relevant scientific references to materials, developing a storyboard to underline the visual and narrative sequence of the video, and the initial draft of research equipment (expert verification and student practicality questionnaire).

Develop phase

This phase constituted the core iterative cycle of the DBR process. The prototype animated video was developed in Canva according to the storyboard. The prototype and the validation instruments were then submitted to the six-member expert panel for review. Experts provided quantitative ratings and qualitative response to content accuracy of material, language clarity and media design quality. The feedbacks were systematically analyzed and used to modify and refine the animated videos to ensure its validity and quality before it was used with students.

Disseminate Phase

In the context of this study, the Disseminate phase involved a small-scale implementation to test the practicality of the refined product. The final version of the animated video was used as a learning medium in the 10th grade chemistry class for chemical bonding topics. Following the lesson, data were collected from the 35 students to assess their perceptions of the video's practicality and usefulness as a learning tool.

Data Collection Intruments

Expert Validator Questionnaire

This tool is designed to assess the content validity of animated videos used as learning media. The instrument consists of a number of items that evaluate several important aspects, such as material accuracy, suitability with pedagogical principles, appropriate language use, and media design quality. Each item is rated using a 4-point scale, where 1 is "Poor," 2 is "Fair," 3 is "Good," and 4 is "Excellent.".

Student Practicality Questionnaire

This instrument was given to students to find out their perceptions of the use of animated videos in learning. Using a 4-point Likert scale, students were asked to rate several aspects, such as how interesting the media was, how easy it was to use, and how helpful it was in helping them understand the material. The results of this instrument are expected to provide an overview of the extent to which animated videos are effective as a learning medium.

Data Analysis

Content Validity Analiysis

The data obtained from the expert validation questionnaire was analyzed using Aiken's V formula, which is used to calculate the content validity coefficient of each item in the instrument. This formula helps determine the extent to which the items are considered relevant by experts. Aiken's V formula is as follows: from the expert validation questionnaires were analyzed using the Aiken's V formula to determine the content validity coefficient for each item. The formula is as follows.

$$V = \frac{\sum s}{n(c-1)} \quad (1)$$

Where V is Aiken's content validity coefficient, n is he number of validators (in this case, 6), c is the highest possible validity rating (in this case, 4), and s is the number given by subtracting r (the rating given by the validator) by l_o (the lowest possible validity rating, in this case, 1). An item was considered valid if its calculated V coefficient met or exceeded the critical value from a standard Aiken's V statistical table for six raters and a four-point scale at a significance level of $p < 0.05$.

Practicality Analysis

The data obtained from the students' practical work was analyzed quantitatively by calculating scores in percentage form. This calculation was performed using the following formula:

$$Percentage\ (p) = \frac{\text{(Total Score Obtained)}}{\text{(Ideal Maximum Score)}}\ x\ 100\% \qquad (2)$$

The resulting percentage was then interpreted using a predefined categorization scale (e.g., 81–100% = Very Good, 61–80% = Good) to determine the overall practicality level of the animated video from the students' perspective.

Result and Discussion

Define Stage Findings

The The initial needs analysis, conducted through interviews with two chemistry teachers at MAN 3 Pontianak, identified the primary challenges in teaching chemical bonding. The interviews revealed that the learning media in use were predominantly traditional, consisting of PowerPoint presentations, textbooks, and whiteboard lectures. Teachers reported that these static media were insufficient for conveying the abstract, microscopic nature of chemical bonding. This was perceived to contribute to low student motivation and boredom with the subject matter.

Design Stage Findings

The design phase culminated in the production of a wide storyboard and the production of a prototype of animated learning videos. The design was directed by the need analysis and formed in a constructionist approach to facilitate the student understanding. The animated video incorporates a narrative structure to attach students by using animated student character, "Andy,", who discovers the concept of chemical bonding through a trip in a "Dream World". This story structure was chosen to make the intangible subject more student-related and less intimidating.

The video has been structured in separate sections, such as: opening, explanation, and conclusion. In the opening section, the characters and learning objectives were introduced. The content explanation uses a "magic board" metaphor to visually explain the main concepts of covalent relationship, including the formation of single, double and triple bonds. Dynamic animations are used to paint electron sharing between atoms. During the conclusions sections, video ends with the character that applies its new knowledge, followed by a summary of major teaching points.

The visual design executed in Canva appoints a clean and colorful aesthetics to maintain the student's attention. The major design elements, such as storyboard observations and a representative frame that reflects the explanation of a covalent bond, is presented in Figure 2 and Figure 3 respectively.

Figure 2. Storyboard

In the third stage, the development process is shown through a scene in which the character Andi interacts with a magic board. The board functions as a visual medium that systematically displays explanations of chemical bonding concepts in a simple, clear, and easy-to-understand manner.

The presentation of material at this stage not only emphasizes the informational aspect, but also seeks to facilitate students' understanding through attractive visualizations. To clarify the sequence of events, this stage is supported by three illustrations that sequentially depict Andi's interaction with the magic board in conveying the concept of chemical bonding.

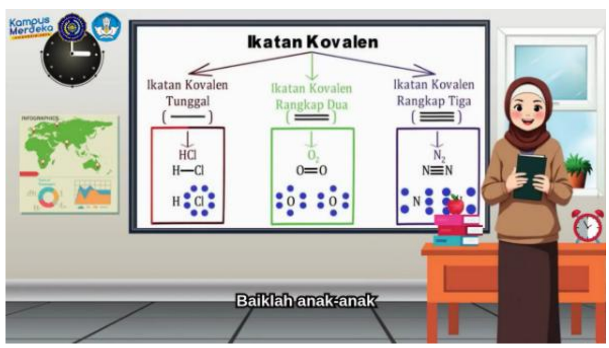

Figure 3. Representative frame explain about covalent bond

Figure 4 presents a visual representation of chemical bonding material, specifically the sub-material of covalent bonding, which covers the process of forming single, double, and triple covalent bonds. The explanation of this concept is conveyed to a student named Andi through an animation medium based on an interactive whiteboard character named Ajib. This systematic and visual presentation of the material aims to facilitate students' understanding of the abstract concept of chemical bonding,as illustrated in Figure 3.

Figure 4. Representative frame explain about process of forming covalent bond

Devlopment Stage Findings

Expert Validation

The animated video prototype and its accompanying instruments underwent a validation process involving a panel of six experts: two language experts, two subject matter experts, one media expert, and one practicing chemistry teacher. The content validity of the materials was quantitatively assessed using the Aiken's V formula. The analysis indicated that all items across the assessed domains—including material accuracy, language clarity, and media design—achieved a validity coefficient that exceeded the predetermined critical value for the given number of raters and scale points ($p<0.05$). Therefore, the developed learning media and instruments were determined to possess strong content validity.

Table 1. Validation results

Aspect	Average V	Categories
Language Expert	0.917	High
Subject Matter Expert	0.939	High
Media Expert	0.875	High

The practicality of the final, validated animated video was evaluated by a class of 35 senior high school students (X C) at MAN 3 Pontianak. Following the instructional session using the video, students completed a practicality questionnaire. The analysis of student responses yielded an overall average score of 90%. According to the predefined assessment criteria, this score corresponds to a "Very Good" practicality rating, indicating a highly positive reception by the target student audience.

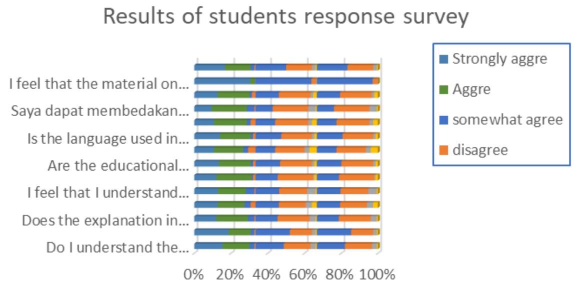

Figure 8. Results Of Student Response Survey To Animated Videos

Discussion

This research and development study successfully produced an animated video for teaching chemical bonding that was confirmed to be valid by a panel of experts and was perceived as highly practical by senior high school students. The primary finding—that an accessible design platform like Canva can be used to create a valid and well-received educational tool for a complex chemistry topic—is significant. It suggests that educators are not reliant on expensive, specialized software to develop high-quality, customized learning resources. The high practicality score of 90% indicates that the animated video was engaging, easy to understand, and a welcome alternative to the traditional lecture-based methods previously identified as a source of student boredom.

The positive student response to the animated video aligns with a substantial body of research demonstrating that dynamic visualizations are particularly effective for teaching abstract scientific concepts (Nio et al., 2024; Setiani, 2023; Susianti, 2024). Chemical bonding is notoriously difficult because it requires students to visualize unseen processes at the molecular level, a task for which static media are poorly suited (Febriani et al., 2024; Whatoni & Sutrisno, 2022) Animated format helps to bridge this gap by creating an abstract concept more tangible, consistent to previous studies on the use of animation in science education (Harahap & Rahmawati, 2024; Zuhdy & Alfi Khoiruman, 2022)

Furthermore, the successful use of Canva extends the findings of other researchers who have highlighted the platform's utility for creating engaging educational materials. While previous studies have shown Canva's effectiveness in various subjects, this research makes a specific contribution by applying and validating its use in the challenging domain of high school chemistry, demonstrating its potential as a solution for a well-documented pedagogical problem. This study provides a replicable process that was absent in much of the prior literature, which often focused on the product's novelty rather than its systematic development.

The findings of this study have important implications for both educational practice and theory. For practice, the most significant practical implication is the empowerment of educators. This study provides a proof-of-concept that teachers can take advantage of low-cost devices such as canva to create their own legitimate, reference-specific and attractive instructional materials. This provides a direct solution to the problem of resource barriers and the challenge of finding the media that fully align with their courses and students' needs.

For theory, framed as a Design-Based Research project, this study contributes to a local theory of instructional design for abstract science topics. It suggests a design principle: intervention for subjects such as chemical relations is most effective when they directly address representative and motivational shortcomings of traditional media, (B) Both subject matter and educational experts are repeatedly valid, and (C) (C) use accessible, visually-oriented design equipment that make up with modern students' digital literature.

Despite these contributions, the study has limitations that must be acknowledged. The research was conducted in a single school with a limited number of participants, which affects the generalizability of the findings. More importantly, this study focused on content validity and practicality; it did not employ an experimental design to measure the video's direct impact on student learning outcomes, such as knowledge retention or the reduction of specific misconceptions.

Therefore, future research should build on these findings in several key directions. First, a quasi-experimental study with pre- and post-tests should be conducted to quantitatively assess the animated video's effect on students' conceptual understanding of chemical bonding compared to traditional methods. Second, the study should be replicated across multiple schools to enhance the generalizability of the practicality findings. Finally, the R&D process outlined here could be applied to develop and test similar Canva-based animated videos for other challenging topics across the chemistry curriculum.

Conclusion

Based Based on the results of the research that has been conducted, it can be concluded that animation-based learning media on chemical bonding material has a very high level of feasibility for use in learning activities. The validation results obtained from experts show an Aiken score of 93% from subject matter experts, 91% from language experts, and 87% from media experts, all of which are classified as "highly feasible," while the responses from 10th grade students show a positive acceptance rate of 86.6%. This data not only illustrates the technical quality of the media developed, but also confirms its relevance as an innovative learning alternative that is able to address the main challenges of chemistry education, namely the difficulty of students in connecting macroscopic, microscopic, and symbolic representations, especially on abstract topics such as chemical bonding. Dynamic, contextual, and interactive visualization through animated videos allows students to obtain a more coherent picture of molecular processes, thereby potentially reducing conceptual misunderstandings and improving understanding of the material. However, this study has limitations because it has not directly measured the impact of media use on improving learning outcomes or reducing student misconceptions. Therefore, further research with experimental or quasi-experimental designs is needed to test the effectiveness of media more comprehensively. From a practical perspective, this study provides a simple, effective, and affordable solution for teachers in presenting abstract chemistry material by utilizing the easily accessible Canva application, while from a theoretical perspective, this study contributes to the development of a systematic design-based framework that can be replicated for other materials with similar characteristics. Thus, it can be asserted that the animated video media developed not only meets the feasibility criteria but also has great potential to enrich pedagogical strategies, improve the quality of chemistry learning, and provide a more meaningful learning experience for students.

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Author Contributions
I. A : formulates research ideas, prepares designs, collects data, and writes the main manuscript. H. M: performs data analysis,

interpretation of results, and revision of manuscript content. R. A: responsible for literature review, documentation, and reference preparation.

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References

Ananda, Y. F., Usmeldi, Giatman, M., & Effendi, H. (2024). Emerging Trends and Impacts of Mobile Learning in Education: A Bibliometric Analysis. *Jurnal Penelitian Pendidikan IPA*, *10*(11), 806–817. https://doi.org/10.29303/jppipa.v10i11.9112

Astuti, S. P. (2021). Pemanfaatan canva design sebagai media pembelajaran mata kuliah fisika listrik statis. *Navigation Physics : Journal of Physics Education*, *3*(1), 8–15. https://doi.org/10.30998/npjpe.v3i1.563

Diniyati, A., & Mastoah, I. (2024). Peran media video animasi interaktif berbasis canva dalam meningkatkan literasi digital siswa sekolah dasar. *Jurnal Inovasi Pendidikan IPA*, *2*(4), 236–245. https://doi.org/10.20961/ddi.v13i2.101350

Febriani, F., Hayyun, H., Nilawati, R., & Abdullah, A. (2024). Analysis of Comprehension Difficulties in Chemistry and Their Impact on Student Interest in Learning. *Jambura Journal of Educational Chemistry*, *6*(2), 103-112. https://doi.org/10.37905/jjec.v6i2.25748

Firda, N., & Lutfi, A. (2025). Kepraktisan E-Komik Interaktif Sebagai Media Pembelajaran pada Materi Ikatan Kimia Kelas XI SMA. *Jurnal Pendidikan Mipa*, *15*(2), 498–550. https://doi.org/10.37630/jpm.v15i2.2711

Gultom, G. F., Parlindungan, J. Y., & Siregar, L. F. (2023). Analisis Miskonsepsi Peserta Didik Kelas X Ipa Pada Materi Ikatan Kimia Menggunakan Instrumen Two-Tier Multiple Choice Sdi Sma Negeri 1 Tanah Miring. *Arfak Chem: Chemistry Education Journal*, *6*(1), 503–515. https://doi.org/10.30862/accej.v6i1.447

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A reviewa. *Sustainable Operations and Computers*, *3*(May), 275–285. https://doi.org/10.1016/j.susoc.2022.05.004

Harahap, Y. M., & Rahmawati, W. T. (2024). Pemanfaatan Canva Animated Video dalam Pembuatan Video Speaking Academic. *Wahana Jurnal Pengabdian kepada Masyarakat*, *3*(2), 70-78. https://doi.org/10.56211/wahana.v3i2.727

Hilmiyati, F., Nafsi, A. G., & Sabri, S. (2024). The Development of Canva-Based Animated Videos to Improve Critical Thinking Skills of Elementary/Islamic Elementary School Students in Science Classes on Human Digestive System Materials. *Al-Aulad: Journal of Islamic Primary Education*, *7*(1), 27–37. https://doi.org/10.15575/al-aulad.v7i1.28770

Husni, H. (2022). Meningkatkan Pemahaman Konsep Peserta Didik Pada Materi Ikatan Kimia Dengan Metode Pembelajaran Example Non Example Menggunakan Animasi Di Kelas X MIPA 1 SMANegeri 6 Kerinci. *Jurnal Ilmiah Dikdaya*, *12*(1), 101. https://doi.org/10.33087/dikdaya.v12i1.280

Karim, B. Q., Haryanto, H., & Susanti, E. Y. (2025). AI in Education: Transforming Student Engagement for the Digital Age. *Jurnal Penelitian Pendidikan IPA*, *11*(2), 1127–1136. https://doi.org/10.29303/jppipa.v11i2.10469

Karuana, R., Latjompoh, M., & Katili, A. S. (2023). Implementation of Stop Motion Graphic Animation Video as Learning Media to Improve Students' Ecoliteracy Ability on the Subject Matter of Environmental Change. *Jurnal Penelitian Pendidikan IPA*, *9*(2), 574–579. https://doi.org/10.29303/jppipa.v9i2.2681

Masayu, & Risa, A. (2019). Pengembangan Elektonik Modul (E-Modul) Interaktif Berbasis Web Dengan Pendekatan Saintifik Pada Materi Ikatan Kimia. *Jurnal Riset Pendidikan Kimia*, *9*(2), 58–66. https://doi.org/10.21009/JRPK.131.02 Pengembangan

Melani, M., Fadhilla, Y., & Leli A. (2024). Meningkatkan Motivasi Belajar dengan Penggunaan Vidio Pembelajaran di MtsS Asy-Syarif Sidang Koto Laweh. *JISPENDIORA Jurnal Ilmu Sosial Pendidikan Dan Humaniora*, *3*(1), 244–251. https://doi.org/10.56910/jispendiora.v3i1.1250

Muskhir, M., Zakaria, Z., & Luthfi, A. (2024). Enhancing Learning Outcomes in Applied Physics Through Web-Based Simulation Media. *Jurnal Penelitian Pendidikan IPA*, *10*(12), 9945–9955. https://doi.org/10.29303/jppipa.v10i12.9281

Ni'mah, K. (2024). Development of Animated Videos Based on the Canva Application as a Learning Media for Arabic Listening Skills Students of Darul 'Ulum Lamongan Islamic University. *ALSUNIYAT: Jurnal Penelitian Bahasa, Sastra, Dan Budaya Arab, 7*(2). Retrieved from https://repository.uin-malang.ac.id/23235/

Nio, P. P. M., Baro, D. A. B., Kwohon, Y. G., & Wangge, Y. S. (2024). Penerapan Media Video Animasi Untuk Meningkatkan Hasil Belajar Siswa Kelas III

Di Sdi Watujara. *Primary Education Journals (Jurnal Ke-SD-An)*, *4*(3), 499–506. https://doi.org/10.36636/primed.v4i3.5811

Nugroho, D. E., & Prayitno, M. A. (2021). Analisis miskonsepsi peserta didik dalam memahami konsep kimia dengan menggunakan tes diagnostik ttmc. *Jurnal Education and Development*, *9*(1), 72–76. https://doi.org/10.37081/ed.v9i1.2300

Pageno, R. B., Salmilah, S., & Wiratman, A. (2024). Pengembangan Media Video Animasi Berbasis Doratoon pada Materi Ekosistem Siswa Kelas V SDN 09 Mattekko. *Jurnal Pendidikan Refleksi*, *12*(4), 241–254. Retrieved from http://www.p3i.my.id/index.php/refleksi/article/view/301

Purnama, Anggraeni, M., & Kusmiyati. (2024). Pengaruh Media Pembelajaran Video Animasi Terhadap Minat dan Kemampuan Membaca Siswa Kelas X di UPTD SMA Negeri Pendabah 1 Kamal. *Eductum: Jurnal Literasi Pendidikan*, *3*(2), 98–110. Retrieved from https://journal.citradharma.org/index.php/eductum

Rahmatullah, R., Inanna, I., & Ampa, A. T. (2020). Media Pembelajaran Audio Visual Berbasis Aplikasi Canva. *Jurnal Pendidikan Ekonomi Undiksha*, *12*(2), 317–327. Retrieved from https://eprints.unm.ac.id/19185/

Setiani, E. A. (2023). *Pengaruh Media Video Animasi Terhadap Pemahaman Konsep Kelas III Di SD Al-Zahra Indonesia*. [Thesis: UIN Jakarta]. Retrieved from https://repository.uinjkt.ac.id/dspace/handle/123456789/72472%0Ahttps://repository.uinjkt.ac.id/dspace/bitstream/123456789/72472/1/11190183000007_Early Azzahra Setiani.pdf

Setyaningsih, E. (2023). Perkembangan Multimedia Digital dan Pembelajaran. *Indonesian Journal of Learning and Instructional Innovation*, *1*(01), 34–48. https://doi.org/10.20961/ijolii.v1i01.920

Sundami, N., & Azhar, M. (2019). Pengembangan Modul Kesetimbangan KimiaBerbasis Inkuiri Terstruktur dengan Menggunakan Tiga Level Representasi Kimia Untuk Siswa Kelas XI SMA. *EduKimia*, *1*(1), 11–20. https://doi.org/10.24036/ekj.v1i1.104018

Susianti, V. A. (2024). Media Pembelajaran Sejarah Melalui Video Animasi pada Layanan Audio Visual Perpustakaan Umum. *Media Informasi*, *33*(2), 181–192. https://doi.org/10.22146/mi.v33i2.15910

Syahrial, S., & Winarni, S. (2021). Pemahaman Konsep Mahasiswa Tahun I Pada Materi Perubahan Fisika dan Kimia. *Chimica Didactica Acta*, *9*(1), 27–32. https://doi.org/10.24815/jcd.v9i1.21210

Tanjung, R. E., & Faiza, D. (2019). Canva Sebagai Media Pembelajaran Pada Mata Pelajaran Dasar listrik dan Elektronika. *Jurnal Vocanational Teknik Elektronika Dan Informatika*, *7*(2), 79–85. https://doi.org/10.24036/voteteknika.v7i2.104261

Ummahati, D., & Suprihatiningrum, J. (2024). Utilizing Animaker in Producing Interactive Chemistry Learning Media on the Topic of Atomic Structure. *Jurnal Penelitian Pendidikan IPA*, *10*(11), 8942–8951. https://doi.org/10.29303/jppipa.v10i11.7573

Utami, I. S., Septiyanto, R. F., Wibowo, F. C., & Suryana, A. (2017). Pengembangan STEM-A (Science, Technology, Engineering, Mathematic and Animation) Berbasis Kearifan Lokal dalam Pembelajaran Fisika. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *6*(1), 67–73. https://doi.org/10.24042/jpifalbiruni.v6i1.1581

Whatoni, A. S., & Sutrisno, H. (2022). Development of A Learning Module Supported by Augmented Reality on Chemical Bonding Material to Improve Interest and Motivation of Students Learning for Senior High School. *Jurnal Penelitian Pendidikan IPA*, *8*(4), 2210–2218. https://doi.org/10.29303/jppipa.v8i4.2057

Wiyarsi, A., Fachriyah, A. R., Supriadi, D., & Bin Muhamad Damanhuri, M. I. (2019). A test of analytical thinking and chemical representation ability on 'rate of reaction' topic. *Cakrawala Pendidikan*, *38*(2), 228–242. https://doi.org/10.21831/cp.v38i2.23062

Zikri, T. A., & Handayani, S. (2024). Development of Electronic Student Worksheets Based on Multiple Representations for High School Students on the Topic of Buffer Solutions. *Jurnal Penelitian Pendidikan IPA*, *10*(5), 2521–2529. https://doi.org/10.29303/jppipa.v10i5.5247

Zuhdy, H. M., & Alfi Khoiruman, M. (2022). Media Pembelajaran Dalam Menghadapi Di Era Society 5.0. *KOLONI:Jurnal Multidisiplin Ilmu*, *1*(2), 2022.

Zuraini, Z., Winarni, S., & Hanum, L. (2020). Kemampuan peserta didik dalam memahami representasi makroskopik, submikroskopik, dan simbolik materi larutan elektrolit dan non elektrolit. *Jurnal Ilmiah Mahasiswa Jurusan Pendidikan Kimia*, *8*(1), 1–12. Retrieved from https://shorturl.asia/IJ9Sn