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Validity of Digital Comics to Train Metacognitive Skills on Thermochemical Materials

Hasna Choiriyah[1*], Rusly Hidayah[2]
Department of Chemistry Education, Faculty of Mathematics and Natural Sciences, Surabaya State University, Jl. Ketintang, Ketintang, Kec. Gayungan, Surabaya City, East Java 60231
[*] Corresponding Author e-mail: ruslyhidayah@unesa.ac.id

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Abstract
The purpose of this study was to determine the validity of digital comics to train students' metacognitive skills on thermochemical material seen from content and construct validation. The novelty of this research is to develop digital comics that have metacognitive components. The research subjects were high school students grade XI. The data used in the pre-research was from 30 students of class XI from one of the state high schools in Magetan. This research uses research and development (R&D) procedures with the ADDIE method, namely analyze, design, develop, implement, and evaluate. But only up to the development stage to find out the validation of digital comics. The instruments used in this study used digital comic review sheets filled in by reviewers and digital comic validation sheets filled in by experts, namely two chemistry lecturers and one chemistry teacher. Based on the results of validation by experts, it shows that the digital comics developed obtained mode 4 for content validation with a valid category, and obtained mode 4 for construct validation to obtain a valid category. Based on the validation results, the developed digital comics can be said to be valid for use as learning media to train students' metacognitive skills.

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INTRODUCTION

The rapid development of technology from year to year always has a great influence on the teaching and learning process. Reporting from the Kominfo website (2022) based on the Indonesian Internet Profile 2022 report released by the Indonesian Internet Service Providers Association or APJII, states that internet users in Indonesia in 2022 are reported to reach 210 million people or 77.02% of the Indonesian population. When compared to the previous period of around 73.7% of 196.71 million people, and 2018 which only amounted to 64.8% of 171.17 million people, internet users in Indonesia have clearly increased. According to Rahayu et al (2022) in the 21st century, teachers and students are required to be literate in digital technology. So digital technology needs to be applied to learning both at school and outside school.

Learning media is a tool used in the learning process to convey complex material into simpler material (Muslim & Ardhana, 2023). The use of learning media can improve student learning outcomes (Aprilia & Lutfi, 2023). At the beginning of learning, students often seem not to pay attention because they are not interested in lessons that are less favored, using visual media can increase students' comfort in learning or reading so that they can easily remember

and understand information conveyed by images (Sumiharsono & Hasanah, 2017). Sumiharsono & Hasanah (2017) argue that visual media is very suitable for use in the teaching and learning process because it can increase students' comfort in learning or reading so that it facilitates students' information processing performance with visual media that has images that attract students to continue to pay attention and try to understand the material in the media.

Digital comics have a combination of visual and digital elements, so they can be used in learning because there is a delivery of messages or problem solving accompanied by learning material accompanied by story elements using simple language and images that make comics more interesting so that the material conveyed is easy to understand and can be accessed anywhere and anytime using the internet (Siregar & Siregar, 2021). Meanwhile, digital comics according to Aggleton (2018) are comics whose publication method is digital and consists of images composed of several (single) parts, aligned reading paths, visible frames, symbols such as word balloons, and writing styles that communicate visual meaning. Visual learning styles are also more attractive to students than other learning styles such as auditory and kinesthetic learning styles (Ramadhani, Syamsurizal, & Afrida, 2022). One of the digital comic platforms in Indonesia is LINE Webtoon. Webtoon can be created and shared by anyone and can freely upload webtoon episodes consisting of stories and graphics on their own blogs within the webtoon platform (Jang & Song, 2017).

Metacognition is the skill of thinking about one's thoughts or oneself (Conyers & Wilson, 2016). According to Sucipto (2017), metacognition is a knowledge or skill about higher thinking processes involving active control or regulation in learning as seen from students' awareness of what they really know in learning. There are three metacognitive indicators or components used in the learning media developed in this study, namely planning, monitoring, and evaluating (Livingston, 2003). The results of pre-research conducted at one of the State High Schools in Magetan using the Metacognitive Awareness Inventory (MAI) (Schraw & Dennison, 1994) questionnaire which was attended by 30 students, stated that the metacognitive skills of students obtained 59% with sufficient criteria. Then the metacognitive component obtained 58% in planning skills, 60% in monitoring skills, and 60% in evaluating skills where the three components received sufficient criteria. So from the results of the pre-research, students' metacognitive skills still have not reached good or very good criteria, so it is necessary to hold learning media to train students' metacognitive skills.

Thermochemical material is part of chemistry material that discusses the heat changes that accompany chemical reactions (Chang, 2010). Thermochemistry is one of the chemical materials that has a broad subject matter with concepts and descriptions so serious understanding is needed (Hidayah & Isma, 2018) and is one of the chemical materials that is considered difficult for students in understanding concepts and how to connect between thermochemical concepts (Mulatsih, 2021). In learning thermochemistry, it is necessary to relate it to everyday life so that learning is more meaningful and easily understood by students (Usmayati, 2010).

Based on the explanation above, the lack of metacognitive skills of students and still difficulty in understanding the concept of thermochemical material, researchers chose to develop learning media in the form of digital comics using thermochemical material to develop students' metacognitive skills. The novelty of this research is to develop digital comics that have metacognitive components. This research aims to produce valid digital comics to train students' metacognitive skills in thermochemical material. The development of digital comics in this study is expected to provide opportunities for students to learn using learning media that are interesting and can be used anywhere and anytime, help teachers in

the process of teaching chemistry lessons, and spur teachers to develop learning media independently so that chemistry learning is more effective and efficient.

METHOD

The target of implementation in this study is grade XI students in one of the public high schools in Magetan with the research time in the even semester of the 2022/2023 school year. The data used in the pre-research was from 30 students of class XI from one of the state high schools in Magetan. The research design used is ADDIE model development research. There are five stages in the ADDIE method, namely Analyze, Design, Develop, Implement, and Evaluate (Branch, 2009). Of the five stages, this study only took three stages, namely analysis, design, and development. The following is the procedure for developing digital comic media in this study.

Analyze

The analysis stage begins with a needs analysis using the Metacognitive Awareness Inventory (MAI) questionnaire developed by Schraw (1994) for students and teacher interviews to find out the problems and characteristics of students. The competency and instructional analysis is in the form of analyzing Core Competency Standards and Basic Competencies as determining indicators and learning objectives contained in learning media in the form of digital comics.

Design

The next stage is product design or design in accordance with the analysis that has been carried out with the design stages in the form of plot preparation in comics, character design, storyboard preparation, and preparation of review and validation instruments. At the stage of preparing the plot in the comic, the plot or storyline in the comic is designed first to determine the storyline presented by the characters in the comic by combining it with thermochemical material so that it becomes a digital comic learning media that has an interesting and structured story (Batubara, 2021). Then for making character designs in the form of the number of characters or characters involved, physical appearance, and other details needed. Preparation of storyboards in the form of comic designs that are arranged based on the plot and material that has been determined. Preparation of feasibility instruments in the form of review and validation instruments. The validation instrument is a content and constructs validation sheet filled in by two lecturers or experts.

Develop

At this stage, the development of digital comics begins to be carried out in accordance with the design where the making of comics uses Clip Studio Paint software, which is then reviewed by the media to provide input and suggestions. After the digital comics are made, the next stage is validation by the validator using the instrument that has been prepared. The instruments used in this research are using review sheets and validation sheets. Determination of validation using mode, which means that the decision is made on the largest number (Lutfi, 2021).

The determination of the validity value is based on a validation questionnaire containing content and construct validation. The validation questionnaire was analyzed using a Likert scale score with the following criteria.

Table 1. Validation Likert (Riduwan, 2015)

Score	Statement
1	Invalid
2	Less Valid
3	Fairly Valid
4	Valid
5	Very Valid

The developed digital comic is declared valid if it has a mode score of ≥ 4, with valid or very valid criteria. Then if there are aspects that do not meet the validity requirements, revisions, and validations must be made again until they reach the specified criteria (Lutfi, 2021).

RESULTS AND DISCUSSION

This study aims to develop digital comics on thermochemical material that contains metacognitive components so that it can train students' metacognitive skills and is valid for use. According to research from Rahayu & Kuswanto (2021) in their research, comics can be used as an alternative in choosing learning media. The procedure for developing digital comic media in this study uses the ADDIE model by only taking three stages as follows.

Analyze

The first stage in this research is an analysis by identifying problems and appropriate solutions by collecting data or information as material in the learning media development process. The needs analysis was carried out by conducting a metacognitive test using the Metacognitive Awareness Inventory (MAI) (Schraw & Dennison, 1994) questionnaire on students and teacher interviews to find out the problems and characteristics of students and schools on February 8, 2023, at one of the State High Schools in Magetan. The results of the MAI questionnaire, which was attended by 30 students, stated that the metacognitive skills of students obtained 59% with sufficient criteria, with each component obtaining 58% in planning skills, 60% in monitoring skills, and 60% in evaluating skills. The three components received sufficient criteria, so students' metacognitive skills can still be improved to good or very good criteria.

Then the results of interviews from teachers, namely digital comic media have never been used as chemistry learning media. The use of electronic devices such as cell phones with android type or others has been used as a medium to access phenomena or material on the internet during chemistry learning. Therefore, students are accustomed to using the internet and android in learning so it is suitable if media development in the form of digital comics is used for learning chemistry. This is by the opinion of Rahayu et al (2022) in the 21st century, teachers and students are required to be literate in digital technology.

Followed by competency and instructional analysis in the form of analyzing Core Competency Standards and Basic Competencies as determining indicators and learning objectives contained in digital comic media. The target school is still using the 2013 curriculum. The chemical material used is thermochemical material on KD 3.4 Explain the concept of enthalpy change of reaction at fixed pressure in thermochemical equations. Based on this KD, the Competency Achievement Indicators are determined including: (a) analyzing heat and energy transfer, (b) identifying systems and environments, (c) distinguishing exotherm and endotherm reactions. Then the learning objectives are determined including: (a) through digital comics students can analyze heat and energy transfer correctly, (b) through digital comics students can identify systems and environments correctly, (c) through digital

comics students can distinguish exotherm and endotherm reactions correctly. Thermochemistry topic was contextual meaning that the concept of matter could be found in everyday life (Rusly Hidayah, Lutfiana, Kurniawan, & Ishma, 2021) and comics related to the context of everyday life help make the learning experience more intense and allow learners to make their connections to science questions. Comics can also be a basis for young people to communicate (Lin & Lin, 2016).

Design

Next is the design or design of the product according to the analysis that has been done. There are sub-stages at the design stage. The first stage is the preparation of a plot for digital comics starting from the phenomenon of heat transfer then discussing the notion of thermochemistry, the concept of heat transfer, and identifying between the system and the environment. Followed by the phenomenon of exotherm and endotherm reactions that can be found in the surrounding environment which then the characters in the comic discuss the concepts of exotherm and endotherm reactions. The use of phenomena in everyday life is because in learning thermochemistry it is necessary to relate it to everyday life so that learning is more meaningful and easily understood by students (Usmayati, 2010).

The preparation of the plot or storyline in the comic aims to determine the storyline presented by the characters in the comic by combining it into thermochemical material and metacognitive components so that it becomes a digital comic learning media that has an interesting story, simple material delivery so that it is easy to understand, and structure. Digital comics are also easy to use anytime and anywhere, this is by the usefulness of the media, which helps overcome the limitations of space, time, energy, and senses (Sumiharsono & Hasanah, 2017). According to Lin (2016) using comics is better than using text media.

The second stage is making character designs in the form of the number of characters or main characters involved, physical appearance, and other necessary details. There are four main characters involved in the story. The four main characters are characters who often appear and are involved in the comic story developed because the main character according to Nurgiyantoro (2013) is the character who is most often told or appears and is interrelated with each other in a story. The following is the main character design in the developed digital comics.

Figure 1. Character Design

The third stage is the preparation of storyboards in the form of comic designs that are arranged based on the plot and material that has been determined. There are six episodes made in digital comics, namely the introduction, prologue, episode 1, episode 2, episode 3, and closing. This research was conducted with two meetings where the prologue, episode 1, and episode 2 were at meeting one. Episode 2, episode 3, and cover at meeting two. The

introductory episode contains comic descriptions, basic competencies, indicators of competency achievement, objectives, instructions for use, and character introductions. In comics, there are metacognitive components including planning skills, monitoring skills, and evaluating skills (Livingston, 2003).

The fourth stage is the preparation of the review and validation instruments. The review instrument was given to the reviewer whose results were in the form of suggestions and comments as revision material. The validation sheet is a content and construct validation sheet filled in by two chemistry lecturers and one chemistry teacher. Determination of validation using mode, which means that the decision is made on the largest number (Lutfi, 2021).

Develop

At this stage, the development of digital comics began in accordance with the design. Comic creation uses Clip Studio Paint software, which is then uploaded on Line Webtoon Indonesia. The platform used to upload digital comics is Line Webtoon. Webtoon can be created and shared by anyone and can freely upload episodes consisting of stories and graphics on their blogs on the webtoon platform (Jang & Song, 2017). Line Webtoon can be accessed for free and easily on various devices, such as android and laptop or Personal Computer (PC), so it can be used anywhere and anytime. Comics are made according to the characteristics of Webtoon, by reading vertically from top to bottom which can make readers understand the storyline quickly (Lestari & Irwansyah, 2020). Comics published on Webtoon can be accessed on android or ios mobile phones. The following are the results of comics that have been uploaded on the Line Webtoon Kanvas page.

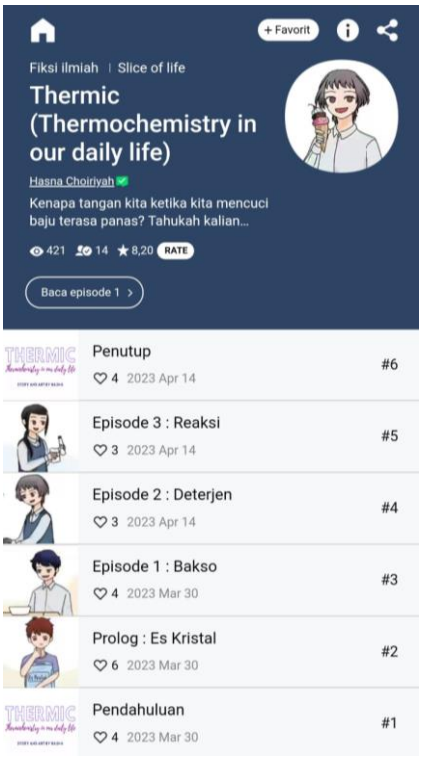

Figure 2. Comics Display on Android

The comic developed is titled "Thermic (Thermochemistry in our daily life)" which means that the phenomenon of thermochemistry can be easily found in everyday life. The material presented in the comics has a relationship with everyday life, this is to research from Affeldt et al (2018) which states that comics related to the context of everyday life help make the learning experience more intense and allow learners to make their connections to science

questions. Thermic Comic can be accessed through the Line Webtoon application or the following link: https://www.webtoons.com/id/challenge/thermic-thermochemistry-in-our-daily-life/list?title_no=857667

The comic developed in this study is a comic that contains metacognitive components with thermochemical material. There are three metacognitive components used in comics, namely planning, monitoring, and evaluating. Planning includes thinking and writing what is known from the phenomenon shown and writing initial information to answer the phenomenon (Livingston, 2003).

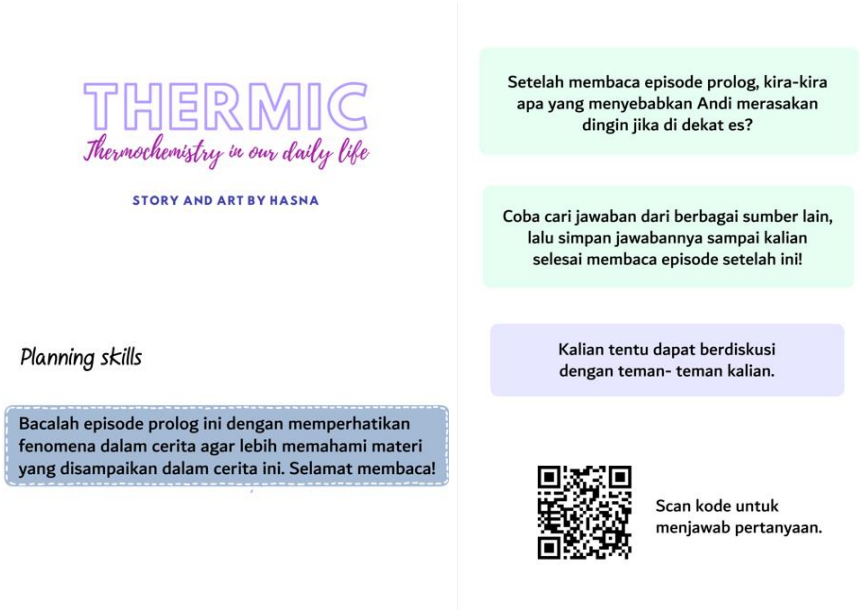

Figure 3. Comic Display on the Planning Component

The monitoring component includes reading the material until you can understand it and monitoring the solution to the phenomenon presented (Livingston, 2003). The following is a comic display of the monitoring component.

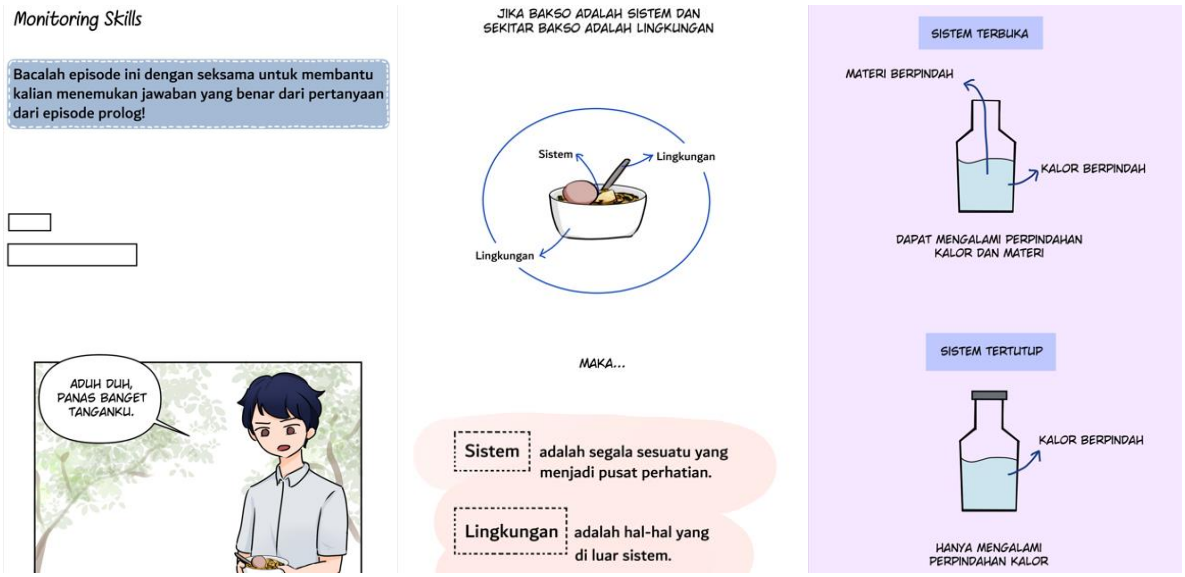

Figure 4. Comic Display on the Monitoring Component

The evaluation includes reflecting on learning strategies and identifying what works and doesn't work by writing down the conclusions that have been obtained after using digital

comics as learning media (Livingston, 2003). The following is a comic display of the evaluation component.

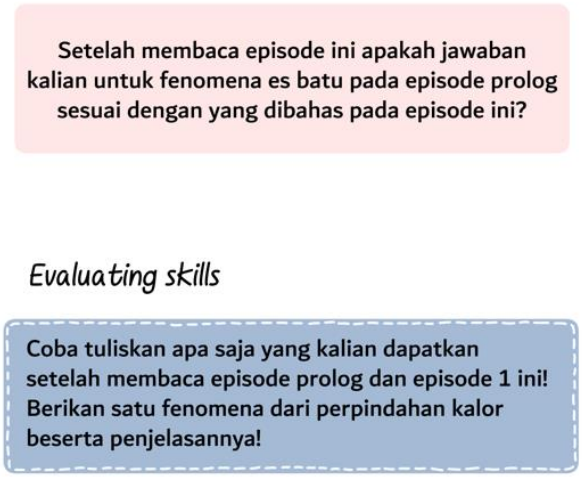

Figure 5. Comic Display on the Evaluation Component

Furthermore, the media consulted with the reviewer to provide input and suggestions. After the review and revision were completed, the next step was media validation by validators using a validation sheet. Validators came from two chemistry lecturers and one chemistry teacher from the target school. In this study there was content and construct validation. Determination of validation using mode, which means that the decision is made on the largest number (Lutfi, 2021). The following are the results of validation using mode.

Table 2. Validation Result

Component	Mode	Criteria
Content		
Materials in digital comics	4	Valid
Indicators of metacognitive skills in digital comics	4	Valid
Story plots in digital comics	4	Valid
Construct		
Language in digital comics	4	Valid
Graphics of digital comics	4	Valid
Presentation of digital comics	4	Valid

Based on the table above, explains that the results of media validation are in mode 4 for the content and construct components with the criteria obtained are valid. The content component consists of material, indicators of metacognitive skills, and story plots in digital comics. The results of content validation obtained in mode 4 with the criteria obtained were valid. The construct component consists of language, grammar, and presentation of digital comics. The results of construct validation obtained mode 4 with valid criteria (Lutfi, 2021).

Based on the results of digital comic validation, it can be said that digital comics are valid for use to train students' metacognitive skills. This is also in accordance with research from Mutammimah & Udaibah (2022) which states that the webtoon digital comics developed are feasible in the media aspect and in the material aspect. Then research from Darmayanti et al (2022) that digital comic media can help and facilitate the learning process and can be used as an alternative for teachers in developing learning media for other learning materials.

CONCLUSION

Based on the results and data analysis in this study, it can be concluded that digital comics to train students' metacognitive skills on thermochemical material are declared valid. The results of content validation, which is seen from the material component, metacognitive skills indicators, and story plots get mode 4 with valid criteria, and construct validation seen from the components of language, graphics, and presentation have mode 4 by getting valid criteria. This research produces a product, namely digital comics that contain metacognitive skills so that it can train students' metacognitive skills on thermochemical material. The development of digital comics in this study can provide opportunities for students to learn to use learning media that are interesting and can be used anywhere and anytime, help teachers in the process of teaching chemistry lessons, and encourage teachers to develop learning media independently so that chemistry learning is more effective and efficient.

RECOMMENDATIONS

After the development of digital comics is complete, this research can be continued for the trial stage to determine the effectiveness of digital comics to train students' metacognitive skills. This research can also be a reference for other researchers to develop digital comics on other materials or skills.

BIBLIOGRAPHY

Affeldt, F., Meinhart, D., & Eilks, I. (2018). The Use of Comics in Experimental Instructions in a Non-formal. *International Journal of Education in Mathematics, Science and Technology*, 92–104.

Aggleton, J. (2018). Defining Digital Comic: A British Library Perspective. *Journal of Graphic Novels and Comics*.

Aprilia, N. L., & Lutfi, A. (2023). Ethnoscience-Based Interactive Multimedia to Improve Scientific Literacy in Chemical Equilibrium Materials. *Hydrogen: Jurnal Kependidikan Kimia*, 242–252.

Batubara, H. H. (2021). *Media Pembelajaran Digital*. Bandung: PT Remaja Rosdakarya.

Branch, R. M. (2009). *Instructional Design: The ADDIE Approach*. New York: Spinger.

Chang, R. (2010). *Chemistry: Tenth Edition* (10th ed.). New York: McGraw-Hill.

Conyers, M., & Wilson, D. (2016). *Teaching Student to Drive Their Brains: Metacognitive Strategies, Activities, and Lesson Ideas*. United States: ASCD.

Darmayanti, R., Sugianto, R., Baiduri, R., Choirudin, & Wawan. (2022). Digital Comic Learning Media Based on Character Values. *Al-Jabar: Jurnal Pendidikan Matematika*, 49–66.

Hidayah, R, & Isma, E. N. (2018). Pengembangan Media Permainan Kartu Domichem pada Materi Termokimia dengan Pendekatan Konstruktivis untuk Melatihkan Keterampilan Berfikir Kritis. *Molluca Journal of Chemistry Education*, 83–88.

Hidayah, Rusly, Lutfiana, L., Kurniawan, A. B., & Ishma, E. F. (2021). Implementation of Techno-Ecopreneurship Worksheet to Train Scientific Literacy Ability among Students in Thermochemistry Topic. *Anatolian Journal of Education*, 17–28.

Jang, W., & Song, J. E. (2017). Webtoon As A New Korean Wave In The Process of Glocalization. *Kritika Kultura*, *29*.

Kominfo. (2022). Kominfo Lanjutkan Lima Program Prioritas di 2023. Retrieved from kominfo.go.id website: https://www.kominfo.go.id/content/detail/44678/kominfo-lanjutkan-lima-program-prioritas-di-2023/0/artikel

Lestari, A. F., & Irwansyah. (2020). Line Webtoon Sebagai Industri Komik Digital. *SOURCE : Jurnal Ilmu Komunikasi*, 134–148.

Lin, S. F., & Lin, H. S. (2016). Learning Nanotechnology with Texts and Comics: the Impacts on Students of Different Achievement Levels. *International Journal of Science Education*, 1373–1391.

Livingston, J. A. (2003). *Metacognition : An Overview*. Retrieved from https://www.researchgate.net/publication/234755498_Metacognition_An_Overview?enrichId=rgreq-69bf7587071a03855dd4effe33c029c3-XXX&enrichSource=Y292ZXJQYWdlOzIzNDc1NTQ5ODtBUzo5NzExNjA1MTQ3NjQ4OEAxNDAwMTY1Njc5OTEz&el=1_x_2&_esc=publicationCoverPdf

Lutfi, A. (2021). *Research and Development (R&D): Implikasi dalam pendidikan kimia*. Jurusan Kimia FMIPA Universitas Negeri Surabaya.

Mulatsih, B. (2021). Pengembangan Tes Diagnostik Kesulitan Belajar Kimia Model Testlet. *Jurnal Pendidikan*, 1–15.

Muslim, F. E., & Ardhana, I. A. (2023). Development of Android-Based Chemistry Virtual Laboratory Media on Acid-Base Materials for 11th Grade High School Students. *Hydrogen: Jurnal Kependidikan Kimia*, 166–177.

Mutammimah, B., & Udaibah, W. (2022). The Development of Learning Media "Petuah Kimia" (A Digital Chemistry Bond Material). *JTK: Jurnal Tadris Kimiya*, 103–113.

Nurgiyantoro, B. (2013). *Teori Pengkajian Fiksi*. Yogyakarta: Gadjah Mada University Press.

Rahayu, M. S., & Kuswanto, H. (2021). The Effectiveness of The Use of The Android-Based Carom Games Comic Integrated to Discovery Learning in Improving Critical Thingking and Mathematical Representation Abilities. *Journal of Technology and Science Education*, 270–283.

Rahayu, R., Iskandar, S., & Abidin, Y. (2022). Inovasi Pembelajaran Abad 21 dan Penerapannya di Indonesia. *Jurnal Basicedu*, 2099–2104.

Ramadhani, W. A., Syamsurizal, & Afrida. (2022). Multimedia Interaktif Menggunakan Articulate Storyline Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa Pada Materi Larutan Penyangga. *Hydrogen: Jurnal Kependidikan Kimia*, 197–208.

Riduwan. (2015). *Skala Pengukuran Variabel-Variabel Penelitian*. Bandung: Alfabeta.

Schraw, G., & Dennison, R. S. (1994). Assessing Metacognitive Awareness. *Contemporary Educational Physcology*, *19*(4), 460–475.

Siregar, A., & Siregar, D. I. (2021). Analisis Evaluasi Pengembangan Media Komik Digital Pada Mata Pelajaran IPA Sekolah Dasar. *Jurnal Sistem Informasi*, 114–126.

Sucipto, S. (2017). Pengembangan Keterampilan Berpikir Tingkat Tinggi dengan Menggunakan Strategi Metakognitif Model Pembelajaran Problem Based Learning. *JP (Jurnal Pendidikan)*, *2*, 77–85.

Sumiharsono, R., & Hasanah, H. (2017). *Media Pembelajaran: Buku Bacaan Wajib Dosen, Guru, dan Calon Pendidik*. Jember: Pustaka Abadi.

Usmayati, S. (2010). *Pengaruh Penggunaan Pendekatan Konstektual Terhadap Penguasaan Konsep Termokimia Yang Terintegrasi Nilai : Quasi Eksperimen di SMA Budi Mulia Ciledug Tangerang*. Jakarta: UIN Syarif Hidayatullah.