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Electronic Learning Media on Chemical Bonding Materials: A Literature Study

Mutipa Ramadani*, Guspatni
Faculty of Mathematics and Natural Sciences, Padang State University, Padang 25131, Indonesia

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* *Corresponding author:*

E-mail: mutipa1101@gmail.com

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A B S T R A C T

Chemical bonding is a basic material that helps students to understand other chemical concepts, because it provides a basic explanation of the process of a reaction. chemical bonding material becomes material that is considered difficult by students because of its abstract concept. Learning media is needed in the learning process, to be able to improve students' understanding, skills, learning outcomes, achievement and motivation to learn. The purpose of this study is to determine the electronic learning media that have been developed and used on chemical bonding materials. This study used of the literature review method from several articles in the research database based on the validity, practicality, and effectiveness values, then analyzed and concluded. The results of this study found 27 electronic learning media in the form of Web site, Electronic Module, Electronic teaching materials, Electronic Learning, Comics, Electronic Book, Video, Audio Visual, Ludo, Animation, Khoot, Computational Chemistry and Power-Point.

1. Introduction

Chemical bonding is one of the main subjects studied in Senior High School. Understanding chemical bonding material is the basis for understanding molecular structure, chemical reactions, thermodynamics and chemical equilibrium (Özmen, 2004). Chemical bonding material explains the process of the same or different atoms forming bonds (Effendy, 2013). Chemical bonding materials are considered difficult by students because they have abstract concepts. So that it causes some misconceptions in the material. Misconceptions occur because students have difficulty in distinguishing ionic bonds and covalent bonds (Hendrawani, 2023). Misconceptions are also based on prerequisite knowledge on determining atomic theories, determining elemental properties, elemental stability and Lewis structure (Noviani & Istiyadji, 2017). Misconceptions also occur because students have difficulty in determining the electron arrangement of an image, determining the possibility of compounds and bonds formed (Karim et al., 2022). This causes low

student learning outcomes because students have difficulty understanding the material.

Learning media in the learning process can be used as an effective learning resource to avoid misconceptions in studying chemistry. Learning media in the learning process can be used as an effective learning resource to avoid misconceptions in studying chemistry (Tasker & Dalton, 2006). Learning media is used as a tool to convey learning messages or information so that learning becomes more effective and efficient (Arsyad, 2019). Learning media can be in the form of text, images, videos, electronic and non-electronic based animations that are in accordance with learning materials that can increase learning motivation (Hasanah, 2021).

Electronic-based learning media can be used as an innovation that can increase students' understanding (Husain et al., 2023). Entering the 21st century, teachers and students are required to have the ability to learn and teach using technology. Electronic learning media can support the learning process. Learning by using technology is also called e-learning, e-learning can make the learning process easier to implement by using the help of these technological tools (Setiawan et al., 2017).

By using electronic learning media, teachers are easier to convey learning because the material can be uniformed, the material presented is also more interesting and clearer so that the quality of learning can improve. learning media also allows students to access it anywhere and anytime (Rasyid et al., 2018). Interesting learning media can improve student learning outcomes and make learning more enjoyable (Harahap & Siregar, 2020). There are many types of electronic learning media that have been developed and can be used, especially in learning chemical bonds which will be discussed in this study. learning outcomes, achievement and motivation to learn. The purpose of this study is to determine the electronic learning media that have been developed and used on chemical bonding materials.

2. Methodology

The research method used in this research is a literature study, which is not based on direct research but is sourced from a summary of references to journals, books and the internet. The literature study aims to analyze, identify and conclude all the data found in a study that has been done before (Kitchenham, 2007). The research procedure is theme selection, searching for information, determining the direction of research, collecting data sources, presenting data, and compiling reports (Kuhlthau, 2002). The findings that have been obtained in this study are used to determine 1) the validity of learning media on chemical bond materials 2) the practicality of learning on chemical bond materials 3) the effectiveness of learning on chemical bond materials.

The types of electronic learning media on chemical bond materials are the focus of this research, by reviewing the validity, practicality, and effectiveness of these

learning media. This research was conducted by searching for related articles on the internet using the keywords electronic learning media, e-learning, e-module, animation, interactive, virtual, android, multimedia, power point, and chemical bond material. The data obtained will be selected and concluded based on the validity, practicality and effectiveness of learning media for chemical bonding materials. the results of this study are presented in the following table:

Table 1. Analysis of Articles Related to the Validity of Learning Media on Chemical Bonding Materials

No	**Analysis of Articles**		
	Title	Identity	Research Results
1	Validity of Website as Learning Media to Improve Creative Thinking Skills on Chemical Bonding Materials	Nuraini, S., & Hidayah, R. (2023). Journal of Chemistry Education Fkip Halu Oleo University, 8(3), 196-207	The website media has met the criteria of being very valid in terms of content (design of learning objectives, material, and suitability for creative thinking skills indicators) and construct (navigation, presentation and language).
2	Development of Web-based Interactive Electronic Module (E-Module) with Scientific Approach on Chemical Bonding Material	Lailatul, A. A., & Ashif, A. I. (2023). Journal of Chemical Education Research, 13(1), 8-15	E-modules have met the valid criteria in terms of material (content feasibility, presentation, and contextual assessment) and media (graphics, language feasibility, and ease of use).
3	Development of Interactive Digital Teaching Materials Based on Kvisoft Flipbook Maker on the Subject Matter of Chemical Bonding for SMA/MA Class X	Nenohai, J. A., Sudirman, Naat, J. N., & Kasimir Sarifudin, (2022). Journal of Beta Kimia, 2(1), 41-50	Teaching materials have met the criteria of being very valid from the material (content feasibility, presentation and language) and media (aspects of content feasibility, presentation and language).
4	Development of Module Based on Multiple Representation with Augmented Reality Technology to Help Students Understand the Concept of Chemical Bonding	Apriani, R., Harun, A. I., Erlina, E., Sahputra, R., & Ulfah, M. (2021). Journal of Science & Science Learning, 5(4), 305-330.	The module has met the criteria of being very valid in terms of material (learning design, material, and presentation), media (media design and software) and language (straightforwardness, communicative, language suitability for students' education level, conformity with Indonesian language rules, and use of terms, symbols and icons).
5	Development of Interactive Powerpoint Learning Media Based on Guided Inquiry on Chemical Bonding Material Class X SMA/MA	Febriani, S. S., & Aini, S. (2021). Anah Research Journal Of Multidisciplinary Research And Development, 215-222.	Interactive Powerpoint has met the criteria of being very valid in terms of attentional functions, affective functions, cognitive functions, and compensatory functions.
6	Development Of Learning Media Based Chemical Adobe Flash Cs4 On	Yona Adi R., Holiwarni, B., & Herdini, H. (2017). Online Journal of Students of the Faculty	Adobe Flash Cs4 media has met the valid criteria in terms of material and media (planning, content, ease of use and pedagodic aspects).

	The Subject Of Chemical Bonding SMA/MA	of Teacher Training and Education, Riau University, 5(4), 1-12.

Tabel 2. Analysis of Articles Related to the Practicality of Learning Media on Chemical Bonding Materials

No	Analysis of Articles		
	Title	Identity	Research Results
1	The Development of Learning Media "Petuah Kimia" (A Digital Chemistry Bond Material)	Mutammimah, B., & Udaibah, W. (2022). JTK (Journal of Tadris Kimiya), 7(1), 103-113.	"Petuah Kimia" media has met the practical criteria with aspects of media assessment (ease of use, usability instructions, usability, and product attractiveness), language (ease of language, accuracy of font type and size, and storyline), and material (the material is conveyed coherently, the media helps readers understand the material, increases interest in reading, and helps independent learning).
2	Development of Digital Comic Learning Media on Chemical Bonding Materials for Class X Science Students	Tsuroyya, Z. N., Yunita, L., & Ramli, M. (2022). Chemical Education, 16(2), 123-130.	Digital comics have met the valid criteria in terms of material (feasibility of content, presentation and language) and media (comic size, comic skin design and comic content design). Digital comics have met the practical criteria with aspects of assessing the feasibility of content, presentation, language and graphics.
3	Design and Trial of Stream-based E-Modules (Science, Technology, Religion, Engineering, Art, And Mathematics) On Chemical Bonding Materials	Melati, A., & Hadi, K. (2022). Proceedings of the National Seminar on Chemical Education, 335-339.	E-modules have met the criteria of being very valid in terms of media (cover design, content design, and language), and material (feasibility of presentation assessment content and contextual feasibility and STREAM). E-modules have met the criteria of being very practical by assessing the aspects of content feasibility, language, graphics, time efficiency, and the benefits of STREAM E-Modules.
4	Development of PowerPoint-iSpring Learning Media Integrated with Prompting Questions on Chemical Bonding Material Class X SMA/MA	Salfitri, A., & Guspatni, G. (2021). Entalpi Chemistry Education, 2(1)	PowerPoint-iSpring has met the criteria of being very valid in terms of attentional function, affective function, cognitive function and compensatory function. PowerPoint-iSpring has met the practical criteria with aspects of assessing ease of use, time efficiency, and attractiveness and

			benefits with a very high practicality category.
5	Development of Comic-Based Chemistry Learning Module Based on Augmented Reality on the Subject Matter of Chemical Bonding	Agussalim, H., Muharram, M., & Danial, M. (2021). Chemistry Education Review, 4(2), 2597	The module has met the valid criteria in terms of content (suitability of the material with SK and KD, accuracy of the material, sophistication of the material and encouragement of curiosity), presentation (presentation techniques, supporting presentation, presentation of learning, coherence and collapse of piker flow), Graphics (size, cover design, and module design), language (straightforwardness, communicative, diaglogical and interactive, suitability for learner development and suitability for language rules) and media (benefits, design, and navigation/operation). The module has met the practical criteria by assessing the aspects of media benefits, module design, media design, navigation, suitability for learning objectives, material quality and content presentation.
6	Development of Module Based on Multiple Representation with Augmented Reality Technology to Help Students Understand the Concept of Chemical Bonding	Apriani, R., Harun, A. I., Erlina, E., Sahputra, R., & Ulfah, M. (2021). Journal of Science and Science Learning, 5(4), 305-330	The module has met the valid criteria in terms of material (aspects of learning design, material and presentation), media (media design and software) and language (straightforward, communicative, language suitability for the level of education, conformity with Indonesian language rules and the use of symbol terms and icons). The module has met the practical criteria by assessing the aspects of learning design, media display, material, software, and benefits.
7	alidity of Chemical Teaching Materials on Exe-Learning Based Chemical Bonding Materials for Senior High School / Equivalent	Herdini, H., Erna, M., & Aminullah, R. (2020). Riau University Journal of Chemical Education, 3(2), 65-76.	Exe- learning has met the valid criteria in terms of pedagogic or content (media content and material content) and construct (design and ease of use). Exe- learning has met the practical criteria with aspects of assessing the quality of teaching materials/technology, material presentation, program interaction and learning design.
8	Development of	Widyastuti, N., &	The learning video has met the

	Advance Organizer Based Learning Video on Material Chemical Bonding	Fitriawan, H. (2021). Cakrawala: Journal of Education, 15(1), 53-63	practical criteria with the assessment aspects of video clarity, learning duration accuracy, video attractiveness, language clarity, increasing learning motivation, writing variations, illustrations, and clarity of learning instructions.
9	Development of Interactive E-Book Based on Chemical Representation on Chemical Bonding Material	Nurmayanti, N., Rosilawati, I., & Fadiawati, N. (2017). Journal of Chemical Education and Learning, 6(1), 139028.	E-books have met the valid criteria in terms of content suitability, construction and readability. E-books have met the practical criteria by assessing the aspects of content suitability, construction, readability and attractiveness.
10	Media Development Based Learning Student Lectora Inspireas Multimedia Interactive Discussion On Cost Of Chemical Bonding In Sma / Equals	Rosye D., Betti. H., & Haryati. S. (2016). Chemistry Education Riau University, 3(5), 1-9.	Learning Student Lectora has met the valid criteria in terms of material and media (didactics, constructs, and techniques). Learning Student Lectora has met the practical criteria with aspects of didactic, construct and technical assessment.
11	Development of E-Modules Using Pageflip 3d Software Professional for Class X Chemistry Learning Al Falah Islamic High School, Jambi City	Asyhar, R., Afrida, A., & Widiastiningsih, W. (2015). Journal of The Indonesian Society of Integrated Chemistry, 7(1), 18-24.	The e-module has met the criteria of being very practical with an assessment of the material, pedagogical, display and language aspects.

Tabel 3. Analysis of Articles Related to the Effectiveness of Learning Media on Chemical Bonding Materials

No	**Analysis Articles**		
	Title	Identity	Research Results
1	Use of Kahoot Learning Media Based on Game Based Learning Learning to Improve Student Learning Outcomes on Chemical Bonding	Laumbo, N., Saiya, A., & Kumajas, J. (2024). General Chemistry Journal, 2(1), 15-20.	Khoot learning media has met the criteria for effectiveness on student learning outcomes from the results of hypothesis testing with the accepted hypothesis.
2	Effect of Computational Chemistry-Based Learning Media Using the Stad Type Cooperative Learning Model on Learning Motivation on the Subject of Chemical Bonding Chemistry	Nababan, T. M. B., & Pratiwi, L. (2023). Journal of Social Education and Humanities, 2(1), 497-501	Computational learning media has an effect on student learning motivation from the results of hypothesis testing with Ha accepted.
3	Implementation of web-based learning media on chemical bonding material	Dalimunthe, M., & Dalimunthe, Q. R. (2023). Implementation. JS (School Journal), 7(2), 318	Web-based learning media has an effect on student learning outcomes from the results of hypothesis testing with Ha being accepted

4	Application of E-book Media in learning chemical bonds in high school	Lingga, A. D., & Silitonga, P. M. (2022). Educenter: Scientific Journal of Education, 1(9), 656-660.	E-books have met the criteria for effectiveness on student learning outcomes from the achievement of KKM scores and the results of hypothesis testing with hypothesis being accepted.
5	Development of Mobile Learning Chemical Bonding to Improving Student Motivation and Learning Outcomes	Khefrianti, S. (2021). Jurnal Guru Dikmen dan Diksus, 4(2), 191-207.	Mobile learning has met the valid criteria in terms of design, material and use. Mobile learning has met the effective criteria from the N-Gain test on student learning motivation and student learning outcomes.
6	Effectiveness of Ludo Word Game (Lwg) as Chemo Edutainment Media to Improve Learners' Learning Outcomes Students on Chemical Bonding Material in Class X Sman 16 Padang	Marni, N. G., & Gazali, F. (2019). Journal of Residu, 13 (3), 18-25.	Ludo Word Game has met the criteria for being effective on student learning outcomes from the results of the experimental class N-gain test which is higher than the control class and the results of hypothesis testing with Ha being accepted.
7	The Effect of Using Bonding Board Learning Media With Visual-based Quantum Teaching Learning Model, Auditory, Kinesthetic (Vak) Toward Student Understanding on Chemical Bonding Material	Simbolon, A. S., Widiyowati, I. I., & Kusumawardani, R. (2018). Bivalent: Chemical Studies Journal, 1(1), 21-26.	Bonding Board Learning Media affects students' understanding of the average value of the experimental class which is higher than the control class.
8	Learning Chemical Bonding Concept with Animation Integrated Touch Screen Lcd Projector (Low Cost Multi Touch White Board)	Agustina, A. (2016). JTK (Journal of Tadris Kimiya), 1(1), 8-13.	The touch screen LCD projector has met the effective criteria in increasing students' understanding and interest in learning from the N-gain test results of students' involvement in the learning process.
9	Application of Problem Based Learning (PBL) Model with Audio Visual Media on Chemical Bonding Material on Concept Mastery and Critical Thinking Students of Sma Negeri 1 Panga	Syaribuddin, S., Khaldun, I., & Musri, M. (2016). Indonesian Journal of Science Education, 4(2), 96-105	Audio Visual Media has met the criteria for effectiveness on concept mastery and critical thinking of students from the average posttest results of the experimental class higher than the control class.
10	he Effect of Animation Media in the Think Pair Share (TPS) Learning Model on Student Learning Outcomes of Science X class of SMAN 1 Pinrang study on the Subject Matter of Chemical Bonds	Salam, M., Muharram, M., & Auliah, A. (2016). Chemica Journal, 17(2), 103-112	Animation media affects the learning outcomes of students from the results of hypothesis testing with Ha being accepted

Tables 1, 2 and 3 show that there are 27 articles that contain electronic learning media on chemical bonding material, where there are 6 articles that discuss the validity of learning media, 11 articles that discuss the practicality of learning

media and 10 articles that discuss the results of the learning media effectiveness test.

Figure 1. Example of electronic learning media (Salfitri & Guspatni, 2021)

Figure 1 shows examples that electronic learning media have been developed in the form of i-spring power point-based learning media integrated with prompting questions on chemical bonding material. The results of the validity of the learning media show that the PowerPoint-iSpring learning media is in accordance with the demands of the Basic Competencies and Competency Achievement Indicators. The developed electronic-based media can help improve students' thinking skills and memory, help increase interest in learning and can help facilitate independent learning. Electronic learning media is made so that students better understand the concept of material to be conveyed, especially on chemical bonding material. by using various kinds of electronic media can help teachers in delivering learning materials so that the material can be conveyed to the sub-macroscopic level.

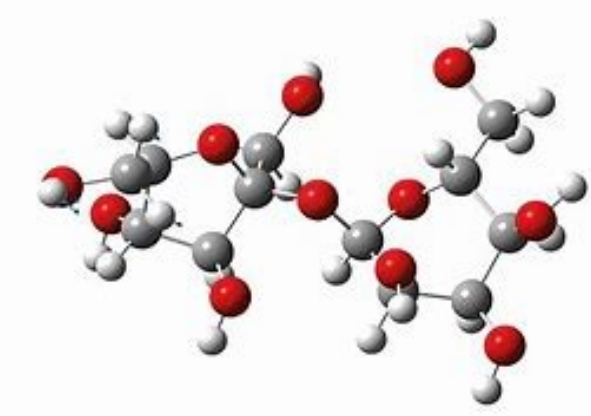

Figure 2. Concepts Abstract on chemical bonds

Figure 2 shows concepts abstract on chemical bonds. The clarity of electronic learning media can illustrate abstract concepts in chemical bonding material and will greatly affect students in understanding chemical bonding material. Because the main purpose of electronic media is to visualize things or concepts that cannot be learned directly due to limitations in the learning process in the classroom.

With the existence of electronic media, it helps students to better understand concepts that are considered difficult in chemical bonding material, especially concepts that are difficult to understand. Chemical bonding material, especially abstract concepts.

The use of media in learning is very good to implement. With the use of media, students become interested in learning chemical bonds. If learning is done only using print media, students will feel bored in understanding chemical bond material which is considered difficult because it has abstract material. Judging from the effectiveness analysis, the most tested media effectiveness or influence is on learning outcomes and understanding of students. the increase in students' scores after being given learning media is evidence that the learning media developed greatly influences students' understanding of the material. Overall, the learning media developed has implemented a learning model. Based on the results of the analysis conducted, there are several learning models used in the learning media developed. Such as guided inquiry, Problem Based Learning (PBL), Quantum Teaching, cooperative, and Think Pair Share. The existence of a learning model on the learning media is used as a guide in planning learning activities so that the learning process with the media can be carried out in stages.

The electronic media developed can make students motivated in learning. Based on a literature study conducted on 27 articles, the most developed electronic media on chemical bonding material is media in the form of E-modules. With the e-module, students understand the material better because the learning process developed is not only reading but using several methods. Another finding is learning media in the form of e-learning. As during the pandemic, electronic media in the form of e-learning is needed because it is able to facilitate internet-based distance learning, where the learning process can be done without face-to-face.

Almost all electronic media developed greatly influence the learning process, making learning more efficient and effective. The media display is more attractive so that it can increase students' interest and motivation to learn. Electronic media also facilitates the delivery of information widely because it supports distance learning, and some electronic media can be used anywhere and anytime. The electronic media developed creates a pleasant learning atmosphere that actively involves students, and is simplified in accordance with learning objectives in order to get full attention by students.

4. Conclusion

The results of the review of articles on electronic learning media on chemical bonding materials that have been developed in the form of Web, E-Modules, Teaching Materials, E-Learning, Comics, E-Books, Videos, Audio Visual, Ludo, Animation, Khoot Chemistry Computing and Power-Point. All media can be used in the learning process and can effectively improve learning outcomes, concept understanding and student motivation. However, the development of electronic

learning media on chemical bonding material is still limited and less diverse and it is hoped that the development of learning media on chemical bonding material can be updated based on the latest curriculum at this time.

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