JPPIPA 11(4) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Development of Website-Based Creative Content as Learning Media on Molecular Geometry

Nahadi[1*], Hayuni Retno Widarti[2], Ari Syahidul Shidiq[3], Wiwi Siswaningsih[1], Atep Rian Nurhadi[1], Triannisa Rahmawati[1], Miarti Khikmatun Nais[1], Rara Djati Anggraeni[1], Hasna Athaya Rifa[1], Rismayanti Chusnul Chotimah[1], Amara Dwi Ayuni [1], Lusiana Citra Aphelia[1], Tanti Oktaviani[1]

[1] Chemistry Education Study Program, FPMIPA, Universitas Pendidikan Indonesia, Bandung, Indonesia
[2] Chemistry Education Study Program, FMIPA, Universitas Negeri Malang, Malang, Indonesia
[3] Chemistry Education Study Program, FKIP, Universitas Sebelas Maret, Surakarta, Indonesia

Received: December 19, 2024
Revised: March 21, 2025
Accepted: April 25, 2025
Published: April 30, 2025

Corresponding Author:
Nahadi
nahadi@upi.edu

DOI: 10.29303/jppipa.v11i4.10116

Abstract: Effective chemistry learning should be designed to actively engage students in various activities that promote deep understanding of abstract concepts, skill enhancement, and positive behavior development. This study aimed to develop creative content based on a website as a learning media for molecular geometry topics. This study uses the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation). The study involved 32 students at the high school, 5 educators, and 3 validators. The results show that 100% of the validators stated that the content developed on the website is valid. The developed content aligns with the material concept, and the learning objectives are based on the needs and expected learning outcomes. Feasibility test results indicate that the website meets the criteria for facilities and media quality, aligning with standards for an ideal learning platform. Therefore, it can be concluded that the creative website-based content developed for molecular geometry is highly suitable and can increase students engagement in the learning process and understanding of abstract chemical concepts.

Keywords: Creative Content; Learning Media; Molecular Geometry; Website Developments

Introduction

Advances in science and technology have a significant impact on various aspects of life, including education (Berlian et al., 2023; Rahmadani et al., 2023). Technology plays a role in supporting the learning process for teachers and students (Oroh et al., 2024). The utilization of technology in the field can improve the quality of the learning process, make it easier for teachers to provide learning instructions and deliver material, and make it easier for students to understand the subject matter through a more interesting approach (Aryanti et al., 2020; Berlian et al., 2023; Cahyana et al., 2019) . Integrating technology into the learning process can create a more interesting and enjoyable learning atmosphere, thus increasing students' interest and motivation to take part in learning activities in the classroom. Along with the development of technology, the role of teachers has also changed, from being a source of information to a manager and innovator in utilizing media to support learning (Januarisman & Ghufron, 2016; Rahmadani et al., 2023).

The learning process needs to be designed so that students can engage in various activities that support the development of behavior, improve skills, and understand concepts in depth (Ahyan et al., 2022;

How to Cite:
Nahadi, N., Widarti, H. R., Shidiq, A. S., Siswaningsih, W., Nurhadi, A. R., Rahmawati, T., … Oktaviani, T. (2025). Development of Website-Based Creative Content as Learning Media on Molecular Geometry. *Jurnal Penelitian Pendidikan IPA*, *11*(4), 900–908. https://doi.org/10.29303/jppipa.v11i4.10116

Suharti et al., 2024). In learning chemistry, students must be actively involved, both physically and mentally, to master the material by maximizing their potential. The teacher-centered approach to learning chemistry tends to cause low interest and motivation of students in learning chemistry (Isaloka & Dwiningsih, 2020; Palma et al., 2021). Molecular geometry is one of the chemical materials that explains the position of atoms in a molecule using several approaches, such as electron domain theory, molecular orbital theory, crystal field theory, and Valence Shell Electron Pair Repulsion Theory (VSEPR). Molecular shapes are often considered difficult because they are abstract, require illustrations to imagine them, and must have a high imagination to understand and predict the shape of a chemical molecule. Many students find this material difficult because it involves inter-atom bond angles surrounding the central atom, and they tend to memorize rather than understand the content of the material. As a result, students become less interested and do not focus on the material being taught. The delivery of material by teachers and the use of inappropriate learning media can cause students to feel bored and have difficulty understanding molecular geometry material. For this reason, molecular geometry material needs to be delivered in the right way so that students are more interested and can understand the material more easily (Achuthan et al., 2018; Pagliaro, 2019; Palma et al., 2021; Rahmadani et al., 2023).

Learning media is a tool used to support the learning process to facilitate the delivery of complex concepts that are difficult to explain directly by the teacher so that it can provide a clearer understanding to students (Ahyan et al., 2022; Rahmadani et al., 2023). Its use is very relevant, especially in molecular geometry subjects (Kohen et al., 2020). One of the utilizations of technology in the field of education is the use of websites as learning media. Web-based learning provides a more enjoyable learning experience, with a high level of interactivity, flexibility in accessing materials, and ease in obtaining information and visualization. Web-based systems not only present text and images but also allow the presentation of multimedia materials such as videos, animations, and graphics that can increase students' interest in learning. Nowadays, the use of web-based learning media or e-learning is increasingly in demand because it provides various advantages, such as ease of access, technological flexibility, platform independence, and compatibility with various systems (Aryanti et al., 2020; Berlian et al., 2023; Dewi et al., 2022; Hardiyansyah* et al., 2024; Mohebifar & Sajadi, 2015) Then another advantage of using the website is that : Media can be accessed via the Internet, making it more flexible; media can be accessed via PC/laptop or mobile device equipped with supporting features such as a web browser; provides a variety of complete content, such as images, interactive 3D animations, videos, concept maps, worksheets, and practice questions (quizzes) to help students deepen their understanding of the material being taught; this media has three types of access rights (admin, teacher, and learner) and is flexible or can change as needed; this media is equipped with features to analyze user activity (Ahyan et al., 2022).

Web-based learning with multimedia and creative content becomes more meaningful because students can interact directly with learning resources and media available. The existence of website-based learning media brings significant innovation in changing the learning process, making it more creative and encouraging students to engage in various activities such as observing, doing, demonstrating, and so on (Aryanti et al., 2020; Berlian et al., 2023; Muskhir & Luthfi, 2024). The use of interactive 3D technology on the website is applied to help students understand the concept of the virtual world, and describe or visualize various forms of molecular geometry (Antonio & Castro, 2023; Hoai et al., 2023; Ragoza et al., 2022). The results of research conducted by Nabuasa et al regarding the use of websites in learning show that students have a high interest in learning of 72.125% after using the website in chemistry learning (Aryanti et al., 2020).

Based on these problems, this study aims to validate the content feasibility and assess the usability of the develop website-based learning media for molecular geometry topics.

Method

The object of this study is website-based multimedia on molecular shape material for students at senior high school. The determination of students for limited trials was carried out randomly with random sampling techniques. This is because this study was conducted on a limited basis by 5 teachers and 32 students who have the characteristics of being or having studied molecular shape material at the high school level.

The research method used is Developmental Research type 1 by (Richey, R.C., Klein, 2005). The developmental research type 1 research method aims to study the development of learning devices. The development model used in this study is ADDIE (Analysis, Design, Development, Evaluation) by (Branch, 2009). The ADDIE development model is a development process that is carried out repeatedly, which is produced from formative evaluation, so that each stage can lead back to each previous stage. The following is a table of research stages using the ADDIE model.

Table 1. ADDIE Research Stages

Stages	Description
Analysis	Analysis of information regarding product needs developed through literature review
Design	Identify and design creative website-based content as a learning media on molecular geometry
Development	Realize the design into a product that is ready to be implemented in learning
Implementation	Implementation of the product to students and teachers to test its validity and feasibility
Evaluation	Evaluate the results of each stage to produce a good website-based creative content product that is suitable for use

(Purba et al., 2023)

The research flow is represented in Figure 1

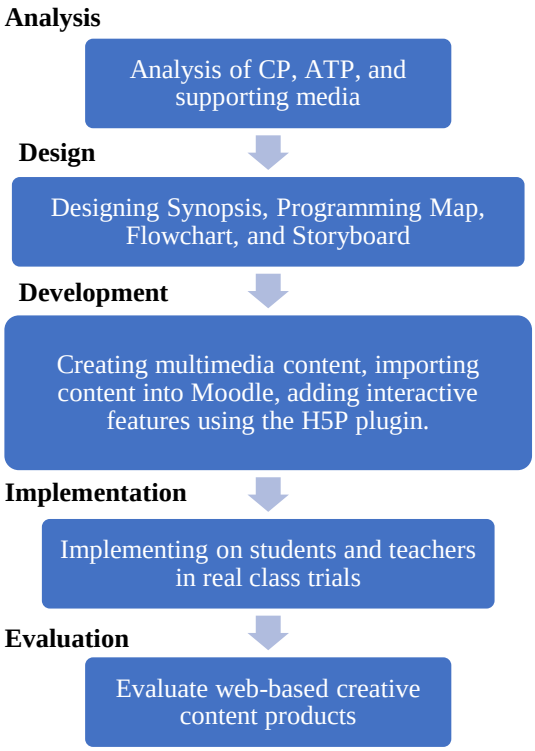

Figure 1. Research Flow

The development of this website-based multimedia goes through the validation and feasibilty test stages. The type of validation test carried out is content validity, which is to evaluate the suitability of the content of the material with the objectives of the curriculum. The feasibility test is carried out at the limited test stage and is assessed by 3 validators, the aspects tested include the suitability of CP (*Capaian Pembelajaran*) and ATP (*Alur Tujuan Pembelajaran*), the suitability of the website display design, the suitability of the content or content of the material on the website, and the suitability of the facilities and quality of the media on the website.

The instrument used in this study was a questionnaire distributed to lecturers as validators, teachers, and students as respondents. The questionnaires filled out by respondents were analyzed quantitatively by means of:

$$\text{Percentage (100\%)} = \frac{\text{total score}}{\text{maximum score}} \times 100\% \quad (1)$$

From the results of the analysis with these calculations, a conclusion will be obtained regarding the feasibility of the media using the Likert Scale, which is an adaptation by (Akdon, 2012) with the following criteria:

0% - 20%: Very unfeasible/very bad
21% - 40%: Unfeasible/bad
41% - 60%: Fairly feasible/fairly good
61% - 80%: feasible/good
81% - 100%: Very feasible/very good

Data collection in this study was then carried out with descriptive analysis. According to Razali (2023), descriptive analysis is an analysis used to collect, present, and describe data with the aim of providing information that has been found, without drawing general conclusions, hypothesis testing, finding relationships, or predicting the data produced.

Result and Discussion

Multimedia creation in this study was developed through several stages in accordance with the established development method. In previous research, the use of the ADDIE development method in multimedia development in the form of a website can produce a feasible product (Ahyan et al, 2022). The results of this study are multimedia that displays explanatory text and 3D animation. Multimedia with 3D animation has received positive responses from students because it is considered to facilitate class X chemistry material (Ahyan et al, 2022). To obtain the instructional media, it is necessary to conduct an analysis in the form of CP and ATP, discourse analysis, and supporting media analysis. Furthermore, the design is carried out by creating a synopsis, programming map, flowchart, and storyboard. Finally, development is carried out by creating multimedia that is in accordance with the results of the analysis and design. Moodle is used as software in creating website-based multimedia. The initial stage in this development is designing multimedia content using Blender, Unity, and Canva software.

In Blender software, it is used to design the geometric shape of the molecule, which is equipped with

the magnitude of the bond angle and the color of each atom that makes up the molecule. The geometric shape that has been created in Blender is then extracted in Unity. In Unity, the previously created molecular geometric shape is coded so that it can be moved and shaped in 3D; in addition, navigation is also developed so that a selection of molecules and information about molecular geometry, electron geometry, bond pair, and lone pair forms appear in each example of the molecule, so that the molecular geometric shape is 3D and becomes interactive. According to previous research, three-dimensional molecular geometry models equipped with animations can enhance students' learning motivation and engagement (Ahyan et al., 2022). In Canva software, it is used to design text and images displayed on the molecular geometric shape material page. This is because Canva has many elements that can be used so that the designs created are more attractive and varied. After multimedia content is created, the content will be imported into Moodle using the H5P plugin to add interactivity features to the multimedia that is developed. According to previous research, the presence of quizzes and small games can add to a better understanding of the material learned (Camel et al, 2020).

To determine the feasibility of the developed website, an assessment was carried out by 3 validators. The assessment data from the validators are in table 2, table 3, figure 2, figure 3, and figure 4. After being validated by the validators, an assessment was carried out by teachers, and a limited trial was carried out on 32 students and an assessment by students who had tried using the developed website. Assessments of teachers and students were carried out by providing a questionnaire in the form of a Google form to see the suitability of CP and ATP, the suitability of the website interface design, the suitability of the content or content of the material on the website, and the suitability of the facilities and quality of the media on the website. From the assessments carried out by validators, teachers, and students, the data obtained are contained in table 3, figure 2, figure 3, and figure 4.

Suitability of Concept Labels and Concept Descriptions

The concept of molecular geometry material contained on the website needs to be tested for suitability/feasibility by experts. The design of learning media, especially the content of the material used, must be feasible before being tested on students (Arikunto, 2015). In this case, the content of the material contained on the website must be categorized as very feasible or appropriate between the concept label and the understanding of the concept based on experts. The results of the suitability of the concept label and concept description can be seen in Table 2.

Table 2. Suitability of Concept Labels and Concept Descriptions

Concept Labels	Suitabilty of Concept Labels and Concept Descriptions		
	The validator Stated That Fisible	%	Category
CL 1	3	100	Very feasible
CL 2	3	100	Very feasible
CL 3	3	100	Very feasible
CL 4	3	100	Very feasible*
CL 5	3	100	Very feasible*
CL 6	3	100	Very feasible
CL 7	3	100	Very feasible
CL 8	3	100	Very feasible*
CL 9	3	100	Very feasible
CL 10	3	100	Very feasible*
CL 11	3	100	Very feasible
CL 12	3	100	Very feasible*
CL 13	3	100	Very feasible
CL 14	3	100	Very feasible
CL 15	3	100	Very feasible
CL 16	3	100	Very feasible
CL 17	3	100	Very feasible*

Caption:
Very Feasible*: Very feasible of revision

In this study, there were three experts who acted as validators in determining the suitability of each concept label with the existing concept description. From 17 concept labels and one conclusion chart, data was obtained that all validators stated that the 17 concept labels and one conclusion chart were in accordance with the existing concept description with a note that concept labels number 4, 5, 8, 10, and the conclusion chart need to go through a revision stage first according to the validator's suggestions. Based on these data, it can be concluded that the concept of the material that has been prepared is appropriate or very feasible to be used for testing on students.

Suitability of CP and ATP

To determine the suitability between CP and ATP, data was obtained from the results of a questionnaire distributed to validators, educators, and students who have used the developed website. From the results of the questionnaire, the data listed in Table 3 was obtained.

Table 3. CP and ATP Compatibility

ATP	Validator	Teachers	Students	Category
ATP 1	100%	100%	100%	Very feasible
ATP 2	100%	100%	100%	Very feasible
ATP 3	100%	100%	100%	Very feasible

The data in Table 3 show that 100% of respondents, both from students, educators, and validators, stated that ATP 1, ATP 2, and ATP 3 were in accordance with the CP. Thus, it can be concluded that all ATPs designed

have met the criteria for conformity with CP. This result shows that the ATPs have been well prepared, in accordance with the needs, and support the achievement of learning objectives. This shows that the ATP is well designed and in accordance with the needs and expected learning outcomes (Akila et al, 2023). Validation from the three groups of respondents also confirmed that the developed ATPs are feasible to use to support the learning process. Based on previous research, this shows that the website developed has high flexibility for the curriculum being used (Camel et al, 2020).

Suitability of Website Interface Design

The responses from these criteria were conducted to determine the suitability of the interface design presented on the website. The results of the questionnaire are listed in Figure 2.

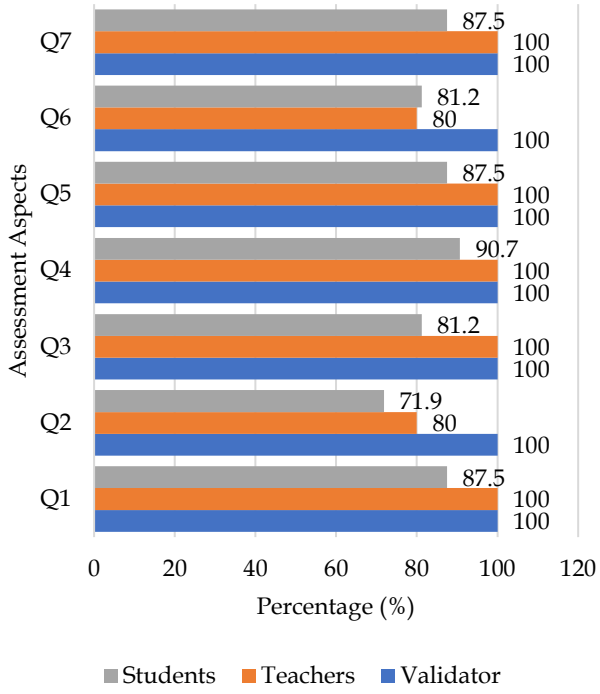

Figure 2. Website Interface Design Conformance Diagram

Caption:

Q1 : Easy-to-understand interface design
Q2 : Buttons are easy to find
Q3 : Buttons work well
Q4 : Navigations works as it should
Q5 : The main menu clearly displays a list of course pages
Q6 : There is clear guidance regarding menus and navigation
Q7 : Pop-up features do not cover information pages

Based on Figure 2 to see the suitability of the interface design on the website that has been used by students, 87.5% of students agreed that the interface design on the website was easy to understand, 71.9% of students agreed that the buttons on the website were easy to find, 81.2% of students agreed that the buttons on the website functioned well, 90.7% of students agreed that the navigation on the website could function properly, 87.5% of students agreed that the main menu presented clearly displays a list of course pages, 81.2% of students agreed that the website has clear guidelines regarding the menu and navigation, and 87.5% of students agreed that the pop-up feature does not cover the information page. Based on these data and the results of the analysis with the criteria, it can be concluded that the design on the website that was developed is categorized as very feasible.

To see the suitability of the interface design on the website from the data obtained from educators, there are 100% of educators who agree that the interface design on the website is easy to understand, the buttons on the website function properly, the navigation on the website can function properly, the main menu presented clearly displays a list of course pages, the pop-up feature does not cover the information page, and 80% of educators agree that the buttons on the website are easy to find and on the website there are clear guidelines regarding the menu and navigation. Based on these data and the results of the analysis with the criteria, it can be concluded that the design on the website developed is categorized as very feasible.

To see the suitability of the interface design on the website from the data obtained from the validators, 100% of the validators agreed that the interface design on the website was easy to understand, the buttons on the website were easy to find, the buttons on the website functioned properly, the navigation on the website could function properly, the main menu presented clearly displays a list of course pages, on the website there are clear guidelines regarding the menu and navigation, the pop-up feature does not cover the information page. Based on these data and the results of the analysis with the criteria, it can be concluded that the design of the website developed is categorized as very feasible.

The three validations from students, educators, and validators confirmed that the interface design on the website developed was in accordance with the criteria. This is in accordance with the criteria for website quality reviewed from the design and navigation capabilities (Moustakis et al., 2004). So, it can be concluded that the website developed based on the suitability of the interface design is very feasible to use.

Suitability of content/material

The responses from these criteria were conducted to determine the suitability of the

content/material presented on the website. The results of the questionnaire are listed in Figure 3.

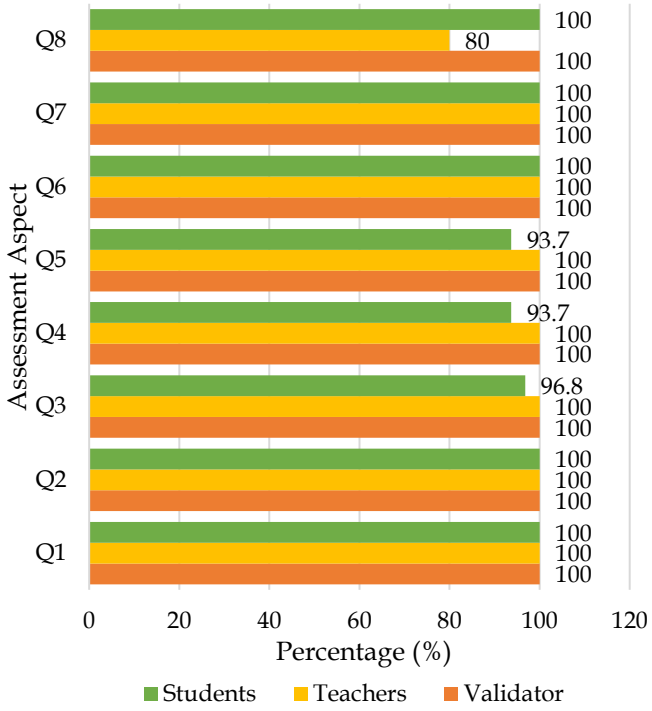

Figure 3 Suitability of Content/Material Diagram

Caption:

Q1 : The material is set according to CP and ATP
Q2 : The discussion of the material presented is easy to understand
Q3 : The content of the material is in accordance with the sequence of learning activity guidlines
Q4 : The content of the material presented helps students understand the material
Q5 : The content of the material in the website can be operated independently by the user
Q6 : The content of the material presented does not cause confusion
Q7 : The animation content presented is in accordance with the concept of the material
Q8 : The quiz content presented is in acordance with the concept of the material

Figure 3. to see the suitability of the content or contents of the material on the website. Based on the assessment of students, 100% of students agree that the material set is in accordance with CP and ATP, the discussion of the material presented is easy to understand, the content of the material is in accordance with the sequence of learning activity guidelines, the content of the material presented does not cause confusion about the concept of the material, the graphic content, videos, and animations presented are in accordance with the concept of the material, and the quiz content presented is in accordance with the concept of the material; 96.8% of students agree that the content of the material presented can help students understand the material; and 93.7% of students agree that the content of the material on the website can be operated independently by users. Based on these data and the results of the analysis with Figure 3, it can be concluded that the content or contents of the material on the website developed are categorized as very suitable for use. Based on the assessment of educators, 100% of educators agreed that the material set was in accordance with CP and ATP, the discussion of the material presented was easy to understand, the content of the material was in accordance with the sequence of learning activity guides, the content of the material presented did not cause confusion regarding the concept of the material, the graphic content, videos, and animations presented were in accordance with the concept of the material, 80% of educators stated that the quiz content presented was in accordance with the concept of the material, the material presented could help students understand the material, and the content of the material on the website could be operated independently by users. This is congruent with research conducted by Susilowati (2021), based on the assessment of educators, the website-based media products developed show high content feasibility.

Based on the assessment of the validator, 100% of validators agreed that the material set was in accordance with CP and ATP, the discussion of the material presented was easy to understand, the content of the material was in accordance with the sequence of learning activity guides, the content of the material presented did not cause confusion regarding the concept of the material, the graphic content, videos, and animations presented were in accordance with the concept of the material, the quiz content presented was in accordance with the concept of the material, the material presented could help students understand the material, and the content of the material on the website could be operated independently by users.

Based on the data that has been presented, the assessment of students, educators, and validators shows that based on the content or contents of the material on the website, it is in accordance with the website quality criteria (Moustakis et al., 2004), so it can be concluded that based on the suitability of the content or contents of the material, the website that was developed is very suitable for use.

Suitability of Facilities and Media Quality

The responses from these criteria were conducted to determine the suitability of the facilities and quality of the media presented on the website. The results of the questionnaire are listed in Figure 4.

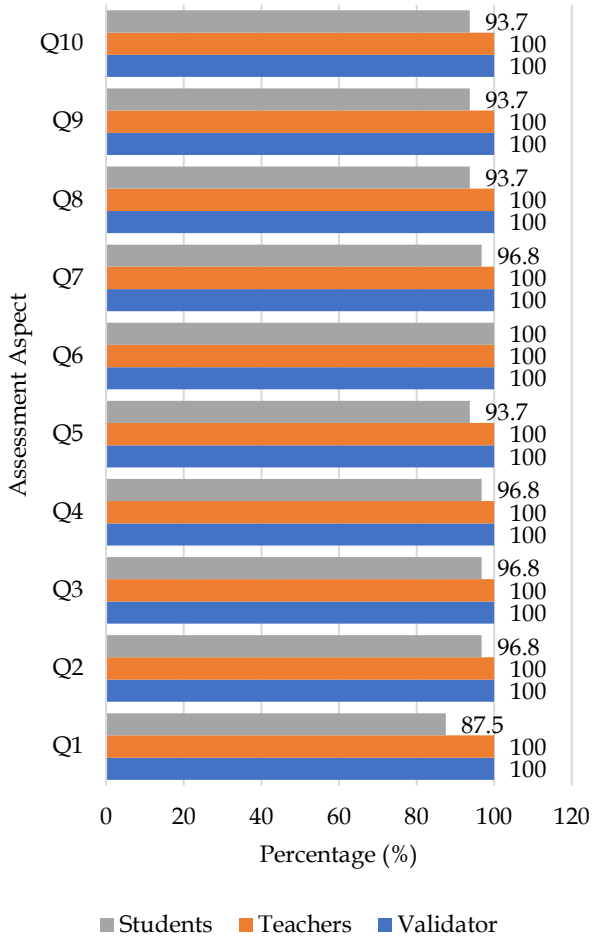

Figure 4. Suitability of Facilities and Media Quality Diagram

Caption:

Q1 : Creative molecular geometry content based on website is easy to access
Q2 : Theme and background used do not interfere with concentration
Q3 : Text color contrast with theme
Q4 : The font used is comfortable to read
Q5 : The font size used is comfortable
Q6 : The graphic display presented is clear
Q7 : The graphics presented can strengthen then understanding of the material
Q8 : The video presented can strengthen understanding of the material
Q9 : The video presented can played smoothly
Q10 : The quiz presented can be used well

Based on Figure 4. for the suitability of facilities and media quality on the website, data obtained from students who have tried the website, there are 100% of students agree that the graphic display presented is clear, 96.8% of students agree that the theme and background used do not interfere with concentration, the text color contrasts with the theme, the font used is comfortable to read, and the graphics presented can strengthen understanding of the material; 93.7% of students agree that the font size used is comfortable to read, the audio presented can strengthen understanding of the material, the video presented can be played smoothly, and the quizzes presented can be used well; and there are 87.5% of students who agree that creative content from website-based molecular forms is easy to access. From the explanation and the results of the analysis with the criteria in Figure 4, it can be concluded that the facilities and media quality on the website are very suitable for use.

For data obtained from educator assessments, there are 100% of educators who agree that the graphic display presented is clear, the theme and background used do not interfere with concentration, the text color contrasts with the theme, the font used is comfortable to read, the graphics presented can strengthen understanding of the material, the font size used is comfortable to read, the audio presented can strengthen the understanding of the material, the video presented can be played smoothly, and the quizzes presented can be used well, and the creative content of the website-based molecular form is easy to access.

For the data obtained from the validator assessment, there were 100% of validators who agreed that the graphic display presented was clear, the theme and background used did not interfere with concentration, the text color contrasted with the theme, the font type used was comfortable to read, the graphics presented could strengthen the understanding of the material, the font size used was comfortable to read, the audio presented could strengthen the understanding of the material, the video presented could be played smoothly, and the quizzes presented could be used well, and the creative content of the website-based molecular form was easy to access.

Based on the data that has been presented, the assessment of students, educators, and validators shows that based on the facilities and media quality on the website, it is in accordance with the website quality criteria (Maustakis et al, 2004), so it can be concluded, based on the suitability of the facilities and media quality, that the website developed is very feasible to use. The same has applied in previous research, the development of website-based media shows decent media facilities and quality on the developed website (Ahyan et al, 2022; Bin, 2014; Camel et al, 2020; Susilowati, 2021).

Conclusion

Based on the assessment results from the validator regarding the suitability of the concept label and the concept description obtained, the concept description is in accordance with the concept label, so it

can be concluded that the concept of molecular geometry material is very suitable for use as content on the website being developed.

Based on students, educators, and validators, it was obtained that the ATP designed for learning on the website being developed is in accordance with the CP for phase F, based on the interface design, content or content of the material, as well as the facilities and quality of the media on the website being developed, which is in accordance with the criteria for website quality. So it can be concluded that the website being developed is very suitable for use.

Acknowledgments

We would like to thank the Rector of UPI, the Ministry of Education, Culture, Research, and Technology, as well as all parties who have provided extraordinary support in the implementation of this research and publication.

Author Contributions

The research team contributed to preparing this scientific work through ideas, conception, data collection, analysis and interpretation of results, drafting, article writing, the revision process, and research funding.

Funding

This research was funded by BOPTN DRTPM (Bantuan Operasional Perguruan Tinggi Negeri), Contact Number: 040/E5/PG.02.00/PL.BATCH.2/2024

Conflicts of Interest

The authors declare no conflict of interest.

References

Achuthan, K., Kolil, V. K., & Diwakar, S. (2018). Using virtual laboratories in chemistry classrooms as interactive tools towards modifying alternate conceptions in molecular symmetry. *Education and Information Technologies*, *23*(6), 2499–2515. https://doi.org/10.1007/s10639-018-9727-1

Ahyan, R. R., Saputra, H. N., & Darman, D. (2022). Development of Web-Based Learning Media as A Chemistry Learning Supplement. *(JINOTEP (Jurnal Inovasi Dan Teknologi Pembelajaran) Kajian Dan Riset Dalam Teknologi Pembelajaran)*, *9*(3), 219. https://doi.org/10.17977/um031v9i32022p219

Akdon, R. (2012). *Rumus dan Data dalam Aplikasi Statistika*. Alfabeta.

Akilla, N., Nurhasanah, N., Saputri, R., & Mustafiyanti, M. (2023). Learning Objectives and Assignment Flow. *Al-Tarbiyah : Jurnal Ilmu Pendidikan Islam*. https://doi.org/10.59059/al-tarbiyah.v2i1.793.

Antonio, R. P., & Castro, R. R. (2023). Effectiveness of Virtual Simulations in Improving Secondary Students' Achievement in Physics: A Meta-Analysis. *International Journal of Instruction*, *16*(2), 533–556. https://doi.org/10.29333/iji.2023.16229a

Arikunto, S. (2015). *Dasar-dasar Evaluasi Pendidikan*. Bumi Aksara.

Aryanti, D., Kasmadi, N. Supardi, I., & Sumarti, S. (2020). Development of the Website based Chemistry Learning Integrated Evaluation To Measure Students Learning Interest In Colloids Material. *Jise*, *9*(1), 12–18. http://journal.unnes.ac.id/sju/index.php/jise

Berlian, L., Taufik, A. N., & Triyani, I. (2023). Need Analysis for Developing a Natural Science Learning Website with the Theme of Biotechnology in Improving Digital Literacy. *Jurnal Penelitian Pendidikan IPA*, *9*(7), 4999–5006. https://doi.org/10.29303/jppipa.v9i7.2934

Branch, R. M. (2009). Instructional Design : The ADDIE Approach. *Springer*, *722*.

Cahyana, U., Supatmi, S., Erdawati, & Rahmawati, Y. (2019). The influence of web-based learning and learning independence toward student's scientific literacy in chemistry course. *International Journal of Instruction*, *12*(4), 655–668. https://doi.org/10.29333/iji.2019.12442a

Camel, V., Maillard, M. N., Piard, J., Dumas, C., Cladière, M., Fitoussi, G., ... & Sicard-Roselli, C. (2020). CHIMACTIV: an open-access website for student-centered learning in analytical chemistry.

Dewi, C. A., Awaliyah, N., Fitriana, N., Darmayani, S., Nasrullah, Setiawan, J., & Irwanto, I. (2022). Using Android-Based E-Module to Improve Students' Digital Literacy on Chemical Bonding. *International Journal of Interactive Mobile Technologies*, *16*(22), 191–208. https://doi.org/10.3991/ijim.v16i22.34151

Hardiyansyah*, M. A., Rohaeti, E., & Haatainen, O. M. (2024). Development of Website based Multiple Representation on Buffer Solution Topic in Chemistry Learning. *Jurnal Pendidikan Sains Indonesia*, *12*(3), 530–546. https://doi.org/10.24815/jpsi.v12i3.37868

Hoai, V. T. T., Son, P. N., Em, V. V. D., & Duc, N. M. (2023). Using 3D molecular structure simulation to develop chemistry competence for Vietnamese students. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(7). https://doi.org/10.29333/ejmste/13345

Isaloka, I., & Dwiningsih, K. (2020). the Development of 3D Interactive Multimedia Oriented Spatial Visually on Polar and Nonpolar Covalent Bonding Materials. *JTK (Jurnal Tadris Kimiya)*, *5*(2), 153–165. https://doi.org/10.15575/jtk.v5i2.8688

Januarisman, E., & Ghufron, A. (2016). Pengembangan Media Pembelajaran Berbasis Web Mata Pelajaran Ilmu Pengetahuan Alam Untuk Siswa Kelas Vii. *Jurnal Inovasi Teknologi Pendidikan*, *3*(2), 166.

https://doi.org/10.21831/jitp.v3i2.8019

Jiang, B. (2014). Web-based cooperative learning in college chemistry teaching. *International Journal of Emerging Technologies in Learning (Online)*, *9*(2), 45.

Kohen, Z., Herscovitz, O., & Dori, Y. J. (2020). How to promote chemical literacy? On-line question posing and communicating with scientists. *Chemistry Education Research and Practice*, *21*(1), 250–266. https://doi.org/10.1039/c9rp00134d

Mohebifar, M., & Sajadi, F. (2015). Chemozart: A web-based 3D molecular structure editor and visualizer platform. *Journal of Cheminformatics*, *7*(1), 1–8. https://doi.org/10.1186/s13321-015-0101-7

Moustakis, V. S., Litos, C., Dalivigas, A., & Tsironis, L. (2004). Website Quality Assessment Criteria. *Proceedings of the Ninth International Conference on Information Quality (ICIQ-04)*, *June 2014*, 59–73.

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

Oroh, C., Pardanus, R. H. W., & Kom, I. S. (2024). Pengembangan Media Pembelajaran Bentuk Molekul 3D Menggunakan Augmented Reality Berbasis Mobile di SMA N 2 Tareran. *Journal of Educational …*, *2*(1), 55–64.

Pagliaro, M. (2019). Chemistry Education Fostering Creativity in the Digital Era. *Israel Journal of Chemistry*, *59*(6), 565–571. https://doi.org/10.1002/ijch.201800179

Palma, Y., Saputra, R., Ulfah, M., Rasmawan, R., Putra Sartika, R., Kimia, P., & Tanjungpura Pontianak, U. (2021). Pengembangan Media Kit Bentuk Molekul Dikelas X Sma Negeri 8 Pontianak. *Jurnal Education and Development Institut Pendidikan Tapanuli Selatan*, *9*(3), 86–91.

Purba, J., Panggabean, F. T. M., Widarma, A., & Sutiani, A. (2023). Development of Online General Chemistry Teaching Materials Integrated with HOTS-Based Media Using the ADDIE Model. *International Journal of Computer Applications Technology and Research*, *11*(05), 155–159. https://doi.org/10.7753/ijcatr1105.1001

Ragoza, M., Masuda, T., & Koes, D. R. (2022). Generating 3D molecules conditional on receptor binding sites with deep generative models. *Chemical Science*, *13*(9), 2701–2713. https://doi.org/10.1039/d1sc05976a

Rahmadani, R., Sholeh, M. I., & Pratiwi, R. Y. (2023). Pengembangan Media Pembelajaran Berbasis Website pada Materi Bentuk Molekul. *Prosiding Seminar Nasional Pendidikan Kimia 2023*, 89–101.

Richey, R.C., Klein, J. D. (2005). *Development Research. Handbook of Research on Educational Communications and Technology*.

Suharti, D. I., Tukiran, & Raharjo. (2024). Validity of Creative Interactive-Web and Seamless Learning Media and Learning Models to Improve Students' Creative Thinking Skills and Cognitive Learning Outcomes in High School Biology Subjects. *Jurnal Penelitian Pendidikan IPA*, *10*(7), 3770–3779. https://doi.org/10.29303/jppipa.v10i7.8279

Susilowati, F. (2021, February). Development and assessment study on web-based chemistry apperception media for teacher. In *Journal of Physics: Conference Series* (Vol. 1779, No. 1, p. 012061). IOP Publishing.