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Analysis of the Characteristics of the Development of Web-Based Science Learning Media with the STEAM Approach

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Abstract: This research aims to analyze the characteristics of developing Web-Based Science Learning Media using the STEAM approach. This research is development research using the Research and Development (R&D) method with the Thiagarajan 4-D Model which consists of definition, design, development and implementation. Based on the validation results from experts and practitioners, the results are very suitable for use and have character because they have an attractive design, ease of use, and color selection that utilizes color psychology. The features provided are very responsive to learning needs, with an effective project-based STEAM learning flow using scaffolding. Users also have access to Google Data Studio to monitor the progress of each student's STEAM stages and processes. Discussion forums provide flexible interaction and feedback, while STEAM learning modules can be downloaded by teachers for more specific learning situations. The conclusion is that the website developed has unique and unique characteristics that combine color, a project-based STEAM learning flow with a real-time scaffolding system and presents features that make it easier for students to learn.

Keywords: Project Based-Learning; Scaffolding; STEAM

Introduction

The digital revolution has changed almost every aspect of human life, including the world of education (Sasono, 2023). The development of increasingly modern technology has become an important means of achieving more effective and efficient educational goals (Tsoraya, et al., 2023). The development of information and communication technology after the COVID-19 pandemic has brought and presented opportunities and provided new challenges that have forced teachers to create new ways of learning that are more dynamic, interactive, and affordable (Maksum et al., 2021).

With the rapid development of technology, learning is no longer bound by space and time. Information can be accessed easily, not only from educators. This encourages innovation in curriculum and learning media (Khomariah, et al., 2020). With this change, educators should innovate by utilizing technology. The innovations carried out will later produce more effective and efficient learning activities which have an impact on attracting students' interest and learning motivation (Khairunnisa, et al., 2021).

Learning innovation in the current era of transformation or digital revolution emphasizes mastery of learning methods by educators, their application in the classroom, and their development in learning by utilizing all potential including mastery of technology and its application in learning (Siregar et al., 2020). One of the learning innovations in the digital transformation era, namely the use of the internet and software has facilitated and changed the paradigm of conventional-based learning. This provides new opportunities for conducting learning that incorporates multimedia that is rich in visuals to illustrate learning (Luo, et al., 2020).

Since the internet network's establishment, the World Wide Web has been considered the most important tool used by all people around the world. The World Wide Web has evolved from a read-only media technology network to a collaborative network where students can connect in a variety of ways (Niaz, et al., 2022). The coverage of web-based learning systems is

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very diverse, one of which can facilitate different student learning styles so that it can increase student learning motivation (Safaan, 2021). One of the web hosting services that is easy to use by all people is Google Sites. Google Sites which free web hosting service provided by Google, through Google Sites can create a website that is used to present various interests on the internet. Google's site has made it easier for users to develop their web with very elegant features, templates, and designs. The appearance can be edited according to what you want and is very practical for users (Harsanto, 2012; Ismawati et al., 2021; Pubian et al., 2022; Suryanto et al., 2018).

The use of the web is a form of media in the learning process, which is an attempt by educators to clarify learning material for students so that it can help improve the quality of learning (Pramadhan, 2021). A good learning media is effective, and efficient, shortens the delivery time of material, and can stimulate students' imaginations when getting factual information through the media. Designed learning media must provide a real picture of something abstract (Yanti, 2022).

The presence of web-based learning that is designed, developed, and utilized as a learning medium, provides unlimited space for students to take part in learning. The contribution of web learning can change students' learning styles to become more effective and efficient with the information available on learning websites that are more interesting, interactive, and interesting materials that increase students' enthusiasm for learning (Kuswanto, 2018).

Although with technological advances in the field of education, we still find in its implementation in the field conditions where students feel bored with learning materials carried out without the use of various media (Zalukhu, et al., 2022; Fauziah, 2022), sources of learning are only limited to printed books at school (Daeli et al., 2022), the media used is not following the material presented (Lia, et al., 2023), learning is always teacher-centered (Hutasoit, 2022). In addition, it was also found that the use of learning media was still very small, so that students were less interested and motivated, when students did not respond to the learning process carried out in class, the learning process was not optimal. On the other hand, with the ability of Gen X and alpha students who are by the time, they can find information from various learning sources on the internet. However, the sources obtained sometimes come from invalid sources (Astiti, 2019).

Based on the results of a preliminary study conducted by researchers regarding the ability to think creatively and science motivation of students at SMP Negeri 65 Central Maluku, the results obtained were that students' creative thinking abilities were still in the less category as much as 23.52%, Enough 70.59% and only 1 student or 5.89% which is in the very good category. Meanwhile, for science motivation, 62.5% of students are in the medium category and 37.5% are in the low category. This is because in learning the teacher still uses conventional learning media which results in a lack of attention and motivation of students to learn which results in learning motivation and students' skills, especially higher-order thinking skills which are less explored. This also results in students in island areas having less ability than those in urban areas due to a lack of exploration of students' abilities and creativity.

This research needs to be carried out because there are many problems that occur in Maluku province related to the lack of science learning media used by teachers, especially those that occur in the Maluku area (Zurimi, et al., 2022; Badelwaer, et al., 2022). Apart from that, the lack of time in science learning at school has an impact on students' lack of time to ask questions, work on questions, the same methods are continuously used by teachers and the absence of use of learning media (Andam Dewi et al., 2021). There are findings that show there is still little research regarding the influence of e-learning media carried out in the Maluku region compared to the island of Java and the form of e-learning used in Maluku is still mobile learning, not yet web-based learning and the form is still simple and uses existing ones (Indriani et al., 2023).

To overcome these problems, the researchers consider it necessary to develop a learning media that accommodates the needs of teachers and students, especially in realizing digital transformation to remote areas. One of the efforts is to develop Web-Based Science Learning Media with a Project-oriented STEAM approach. STEAM is an approach that aims to prepare students to solve problems with innovative, creative, critical thinking, collaboration, and communication to obtain new information or knowledge (Quigley et al., 2016). STEAM can help students by developing innovative solutions where creativity is associated with art and used as one of the advantages or learning objectives of STEAM education (Conradty et al., 2019). This provides evidence that STEAM can help students maintain or continue their scientific creativity (Tran, et al. 2021). Based on previous research, Project Based Learning (PjBL) built in STEAM learning can improve students' 21st-century skills, namely, critical thinking, problem-solving, creativity, collaboration, communication, and scientific literacy (Zayyinah, et al., 2022). Based on these problems, this study aims to analyze the characteristics of the development of web-based science learning media with the STEAM approach in realizing the digitalization of learning transformation.

Method

The type of research used in this research is development research using the Research and Development (R&D) method. The model used in this development research is 4-D developed by Thiagarajan which consists of four stages of development, namely define, design, develop, and disseminate.

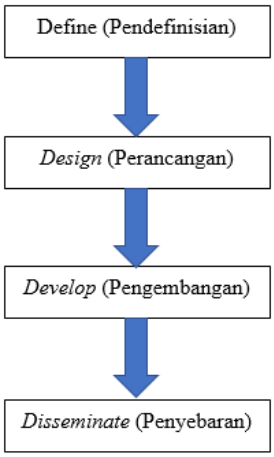

Figure 1. R&D research flow

This research will focus on the design and development stage of instructional media which involves assessments based on media and material experts as well as 7 education practitioners to improve the quality of the media. This development stage aims to produce learning media that have been revised based on the input provided by experts. This stage includes the process of validating the device by experts, which is then followed by the revision stage based on the feedback provided by them.

In this study, data collection involved a non-test method in the form of a questionnaire. The questionnaire consists of a total of 12 questions focused on media validation, covering aspects of usability, navigation systems, and visual design. In addition, there are also 15 questions aimed at aspects of learning design, the content of the material presented, as well as the language and communication used in the developed learning media. This method is designed to obtain comprehensive input from experts regarding the effectiveness and quality of instructional media that are currently under development. The formula used as a reference in analyzing expert and practitioner validation data according to Akbar (2015) is as follows.

$$V - ah = \frac{Tse}{Tsh} \times 100\% \quad (1)$$

The validation criteria are based on the results of the final validation score using the reference according to Muriati (Basri et al., 2022) as in Table 1.

Table 1. Validation Criteria

Criteria	Level of Validity
81 – 100%	Very valid, or usable without revision
61 – 80%	Valid or can be used but needs to be revised
41 – 60%	Invalid, it is recommended not to use it because it needs major revision
21 – 40%	invalid or may not be used
0 – 20%	Very invalid or should not be used

Source: (Basri et al., 2022)

Result and Discussion

The media validation process is carried out for two weeks with the condition that learning media is said to be valid if it is of medium to very good quality. Meanwhile, assessment results that receive a poor score are rejected for a revision process (Sofnidar, 2018). with validators, namely those who are competent and able to provide input/suggestions to improve the learning media that have been prepared. The results of the media validator for the development of learning media are shown in Table 2.

Table 2. Media Expert Validation Results

Aspect	Score
Utility	16
Navigation System	12
Visual Design	18
Total Score	46
Percentage (%)	95.83%
Criteria	Very Valid

(Source: Research Results)

Table 2, illustrates the results of expert validation by media validators having a percentage of 95.83%, with a very valid category and can be used without revision. The results of the material validator on the development of learning media are shown in Table 3.

Table 3. Material Expert Validation Results

Aspect	Score
Learning Design	19
Content Material	21
Language and Communication	16
Total Score	56
Percentage (%)	93.33%
Criteria	Very Valid

(Source: Research Results)

Table 3, illustrates the results of expert validation by the material validator having a percentage of 93.33%, with a very valid/feasible category and can be used without revision. Then the learning media is carried out. The feasibility test of science learning media by expert practitioners consists of 4 main assessment indicators.

The recapitulation of the feasibility validation results of web-based science learning media with the STEAM approach by expert practitioners can be seen in Table 4.

Table 4. Practitioner Validation Results

Res	Media		Material		Criteria
	Score	P (%)	Score	P (%)	
P1	48	100	56	93.33	Very Valid
P2	48	100	58	96.66	Very Valid
P3	48	100	58	96.66	Very Valid
P4	43	89.58	57	95	Very Valid
P5	48	100	60	100	Very Valid
P6	43	89.58	60	100	Very Valid
P7	47	98	56	93.33	Very Valid

(Source: Research Results)

Based on the general assessment results of practitioner validators as shown in Table 4, it is known that the web-based science learning media with the STEAM approach developed can be used without revision. In carrying out expert validation, there are several suggestions given by the material validator to insert material by local wisdom in the student's environment so that the material presented is contextual to students. Then based on the results of expert validation it is used as a product that is suitable for use.

Web-based science learning media with the STEAM approach that has been carried out has characteristics that distinguish it from previous studies. The developed website has a design that is easy to use and eye-catching. Web-based learning becomes a tool for continuing knowledge by providing opportunities for instructor-student interaction which impacts student commitment and improves the teaching and learning environment (Togas et al. 2021; Jaaman et al., 2013). In developing the web design, the color selection method is used based on color psychology. The selection of basic colors in the developed media includes red (giving energy and calling for the implementation of an action), yellow (stimulating mind and mental activity that helps logical and analytical reasoning), blue (dark blue can stimulate clear thinking and blue) youthful helps calm the mind and improves concentration) and orange (gives a warm and vibrant impression and is a symbol of adventure, optimism, confidence, and social skills). In developing web-based science learning media, features are made that have characteristics to provide comfort to users.

Figure 2. Front View of the Website

Figure 3. Website Menu Display

The characteristic feature of the developed web-based science learning media is that the learning flow of this website uses a project-based STEAM flow. This STEAM learning flow provides opportunities for students to experience more holistic and contextual learning (Fatimah, 2022). Apart from that, several elements of the STEAM approach itself are included: Science, Technology, Engineering, Arts, and Mathematics. It also contains three important components of the STEAM approach, namely, Contextual, Design, and socio-emotional (Naili, 2021). When presented in a web-based flow, students can get a more in-depth, interactive, and adaptive experience (Yuliana, 2019). In developing web-based learning media instructional scaffolds were also developed (MacGregor, 2005; Kim et al., 2019; Valencia-Vallejo et al., 2019). Where templates with concept mapping are coordinated or conditioned by giving research instructions which also provide opportunities for students to be creative and innovate.

Apart from that, the STEAM learning flow is also supported by a scaffolding system which helps students with various learning style backgrounds to understand the flow and knowledge built on the website. By using scaffolding techniques, a teacher or instructor can identify learning difficulties at various stages of the learning process and take corrective action to achieve optimal results (Krishnan, 2019).

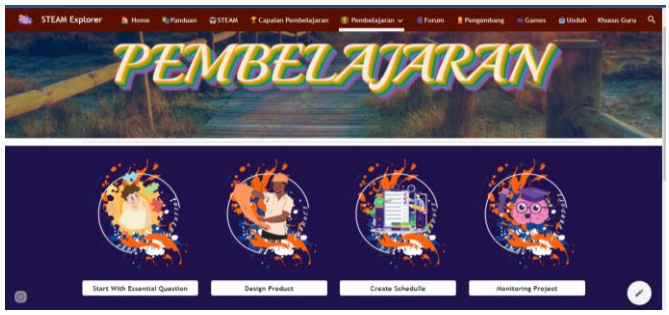

Figure 4. STEAM Learning Flow

Each menu in this flow uses Google Data Studio which allows users, both teachers and students, to see the progress of project-based learning in real-time in the form of discussion results, project design, project scheduling, monitoring, and evaluation so that the learning process becomes transparent. with Google Data Studio view data becomes more interesting and informative. By analyzing and visualizing data Saputra et al. (2023), so that we as teachers can easily provide feedback and assessment of students. with the presence

of this feature, it helps teachers provide feedback, which according to Morry (Slamet, 2020), the constructive effect of feedback in learning is, helping students to think better, helping solve problems, appearing in negotiations between friends, providing guidance, guiding students through situations that may be complicated, and always remind them of their goals. Lastly, it encourages students to continue learning and growing.

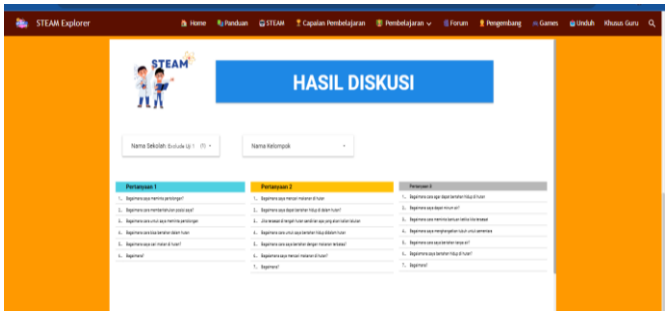

Figure 5. Real-Time Discussion Results Web Display

Besides that, in the web-based science learning media with the STEAM approach that we have developed, a discussion forum is provided that serves as a place to provide feedback and ask questions if students are still experiencing difficulties in learning wherever and whenever it can be accessed. According to Fatmawati (2019) discussion is a form of scientific dialogue carried out by several people in one group with the aim of exchanging opinions about problems to find solutions together so as to get answers and the truth of the problem. The main function of the forum is as a place for students, teachers, or other participants to discuss, share ideas, and exchange views. Forums allow users to initiate discussion topics, provide feedback, and ask questions, which supports discussion and reflection-based learning (Effendy et al., 2016). Learning time at school can be used effectively and efficiently.

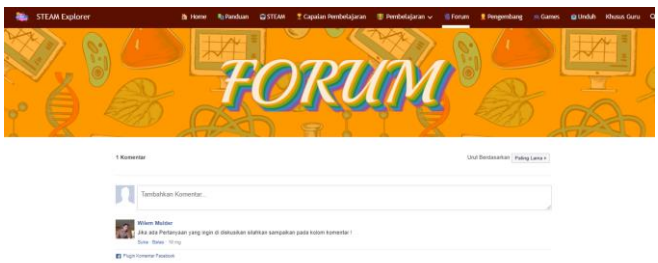

Figure 6. Discussion forum view

Which is the most important point in the development of this media that makes a difference with science learning websites, in general, is that it provides download features specifically for teachers where there is a STEAM-based Science learning module for temperature and heat material. this is intended if there is a blackout, the network is less stable at the location and things that are not desirable then this module can be used in the learning process. The module is also connected to the features and flow of web-based science learning media with the STEAM Approach.

Conclusion

Web-based science learning media with a STEAM approach was developed and has obtained very valid validation results that can be used with different characteristics because it has an attractive design, ease of use, and color selection that utilizes color psychology. The features provided are very responsive to learning needs, with an effective project-based STEAM learning flow using scaffolding. Users also have access to Google Data Studio to monitor the progress of each student's STEAM stage and process. Discussion forums provide flexible interaction and feedback, while STEAM learning modules can be downloaded by teachers for more specific learning situations.

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Author Contributions
This research contributes to empowering and improving the quality of digital learning media, especially those related to STEAM and used by science teachers. The author is involved in the entire creation of this.

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Conflicts of Interest
The author declares that there is no conflict of interest regarding the publication of this paper.

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