Proceeding of Integrative Science Education Seminar Vol. 5 No. 1, 2025, pp. 16 - 25

Available online at

PISCES

Proceeding of Integrative Science Education Seminar

Beranda prosiding : https://prosiding.iainponorogo.ac.id/index.php/pisces

Artikel

Learning Innovation of Science Integration: Grow and Flow as a Media of on Germination and Circuit Concepts

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Info Artikel

5th AVES
Annual Virtual Conference of Education and Science 2025

Kata kunci:

Innovatice Learning Media
Seed Germination and Seri-Paralel Sircuit
3D Model Design
Research and Development (R&D)

ABSTRACT

In the era of educational technology advancement, the need for learning media that provides authentic experiences and promotes student interactivity is rapidly increasing. This study focuses on developing learning media designed to help students understand each stage of seed germination integrated with the concepts of series and parallel electrical circuits through visually appealing and contextual displays. Making learning more active, meaningful, and enjoyable. The research employs a Research and Development (R&D) method consisting of 3D: define, design, and development. During the definition stage, a needs analysis and identification of problems in existing science learning media were conducted. In the design stage, an innovative prototype of science learning media was produced, while in the development stage, feasibility testing was carried out through validation by subject matter experts. The validation results obtained a score of 4.36 within the range of 4.21–5.00, indicating that the product is highly feasible for classroom implementation. The implication of this study is that the developed media can improve students' conceptual understanding, creativity, and participation in learning. The recommendation emphasizes conducting further classroom effectiveness testing and developing interactive features to enhance quality and relevance in 21st-century learning environments.

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INTRODUCTION

Learning is an accumulation of teaching and learning concepts. The emphasis is on a combination of both, with the aim of fostering student activity. These concepts form a system so that in this learning process there are components of students or learners, objectives, materials to achieve the objectives, facilities, procedures, and learning media or tools that will be prepared (Khasanah et al., 2022). Education is one of the important elements in creating superior human resources. In the context of science education, Natural Sciences (IPA) play a significant role in shaping scientific thinking, problem-solving skills, and concern for the surrounding environment (Trianto, 2015). Natural Sciences learning should not only focus on theoretical understanding but also on students' ability to connect these theories with real events in their surroundings.

Learning media plays a very important role in the educational process because it functions as a means of conveying messages and information so that students can understand

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the material more clearly and meaningfully. According to Nurrita (2018), learning media is a tool used to convey messages in learning activities so that it can stimulate students' minds, feelings, attention, and interest to make the learning process effective and efficient. Meanwhile, Supriyono (2018) emphasizes that media not only helps teachers explain material, but also helps students understand abstract concepts in a more concrete way. The use of media can take the form of pictures, models, teaching aids, and even real objects that help strengthen students' understanding. In addition, Falahudin (2014) adds that media can provide a more realistic learning experience, increase motivation, and strengthen students' memory of the material.

The role of learning media in realizing the learning process is to provide meaningful experiences to students to foster good learning motivation, making it easier to understand the material, and making it simpler but building interest in learning in the classroom (Asnawi and Usman, 2002). The choice of learning media is very important so that learning objectives can be achieved. Teachers are required to be skilled in selecting, adapting, and using media in the learning process. The use of learning media is very important in the learning process in all subjects, one of which is science subjects. Teachers are expected to be able to choose appropriate and interesting learning media to use in learning activities so that learning objectives are achieved. Learning media that is attractive to students can be a stimulus for students in the learning process (Nurrita, 2018). One of the learning media that is expected to attract students' attention is teaching aids. Teaching aids are learning media that can be used to help confirm students' abstract understanding. The purpose of using teaching aids is so that learning becomes active and creative and helps students understand the materi (Sidiq & Syaripudin, 2018).

The benefits of teaching aids in the learning process are: (1) Students' attention can be focused, (2) Helping students to receive and understand the lesson material, (3) Increasing students' enthusiasm and enthusiasm for learning, (4) Learning with appropriate teaching aids. combining theoretical and practical approaches as well as abstract and concrete ones will help students master the material, (5) Stimulate reasoning and thinking power, and (6) Increase creativity and imagination (Kaltsum, 2017). The use of teaching aids in the learning process will help communicate ideas that are concrete in nature, besides that it can also help students to integrate previously acquired experiences. So it is hoped that teaching aids will be able to speed up students' learning processes as well as increase understanding and strengthen students' memory (Telaumbauna, 2020). Considering the important role of learning media, one of which is teaching aids as an effort to improve the quality of education, teachers are expected to be able to choose and use teaching aids that are appropriate to the concepts being taught or discussed.

However, in reality, science education in schools still largely uses traditional methods, where learning is more focused on the teacher and does not involve students in activities or experiments directly. This causes many students to have difficulty understanding abstract concepts in science education, such as electrical circuits, current, and voltage, because they are not related to real-life experiences. More than 60% of junior high school students have difficulty understanding the difference between series and parallel electrical circuits because learning is still theory-oriented rather than practice-oriented (Harsanti, 2024).

Meanwhile, in science education, biological aspects are often demonstrated through simple direct observation activities such as looking at leaves, plant parts, or the process of seed germination. Such activities certainly provide real experiences, but they do not yet apply an integrated approach that links to other fields of science such as physics and chemistry. Meanwhile, natural phenomena cannot stand alone; many aspects of biology can be understood using the principles of physics and vice versa. The current Merdeka Curriculum emphasizes the importance of project-based learning and cross-disciplinary integration. This is in line with the goals of education in the 21st century, which aim to develop critical, creative, collaborative,

and communicative thinking skills (4C). Science learning is expected to not only expand knowledge but also skills and attitudes. Therefore, innovation in learning is needed that can combine various fields of science and encourage active student participation. Based on these needs, the author came up with a creative idea called Grow and Flow Innovation, which is a learning approach that combines the concept of series-parallel electrical circuits with plant growth experiments. The term Grow and Flow comes from two core words, namely Grow (plant growth or germination) and Flow (electric current). The main principle of this innovation is to integrate two disciplines of science, physics and biology, in the germination material taught in the first semester of ninth grade junior high school, chapter 1, while the electrical circuit material is in chapter 4. The two materials are linked because when studying the concept of electrical circuits, students already have a basic understanding from previous lessons. Thus, combining germination and electrical circuit material can help students integrate biological and physical concepts, resulting in relevant, interesting, and meaningful learning tools or media for students, making learning more contextual and meaningful.

Through the Grow and Flow media, students can understand how electric current flows in series and parallel circuits while observing the process of seed development into sprouts. The lights in the series and parallel circuits function as light sources with different intensities for plants. Through this, students can observe how variations in light intensity produced by the two electrical circuits affect the germination and growth processes. This medium not only helps students understand electrical concepts in a more tangible way, but also provides direct experience of the relationship between energy and life. Thus, students realize that scientific concepts are interrelated and connected to everyday life. In addition, the Grow and Flow innovation can increase student engagement because they are directly involved in designing experiments, collecting data, analyzing results, and drawing conclusions. This is in line with the inquiry-based learning approach that places students as discoverers of knowledge, not just recipients of information (Sanjaya, 2016).

METHOD

This research uses a research and development (R&D) method consisting of 3D: (definition, design, and development) adapted from the general R&D development model. This model was chosen because it is suitable for producing learning media that is not only oriented towards the final result (product) but also goes through the stages of needs analysis, design, and product feasibility testing in a systematic manner. The first stage of the research was definition, which aimed to identify the needs and characteristic problems of the students and the material to be developed to facilitate the delivery of the lesson material. The second stage was design, which aimed to design an initial prototype of the learning media to be developed, namely Grow & Flow Media for Germination and Electric Current. The third stage is development, which aims to produce a final learning media product that is suitable for use. At this stage, the researcher conducted a validity test on the learning media that had been developed with four science teachers at junior high schools. The media expert validation instrument consists of six components, namely Material Suitability with three criteria, Tool Durability with three criteria, Tool Accuracy with two criteria, Tool Efficiency with three criteria, Aesthetics with one criterion, and Tool Safety with three criteria. Then, the validation results are calculated using a formula.

Average Rating per Validators

$$\text{Final score} = \frac{\sum \text{Score obtained}}{\sum \text{Item score}}$$

Final Value of Validation Test

$$\text{Final value of validator test} = \frac{\sum \text{validator final value}}{\sum \text{validator final value item}}$$

The eligibility criteria for media instruments are as follows.

Score Interval	Information
1,00 – 1,80	Very Bad
1.81 – 2,60	Bad
2,61 – 3,40	Netral
3,41 – 4,20	Good
4,21 – 5,00	Very good

Table 1. Media instrument feasibility criteria

(Umar. 2011)

RESULTS AND DISCUSSION

The results of this learning media research used a predetermined research method obtained through the application of a 3D development model consisting of the define, design, and development stages. Through these three stages, the research process was carried out systematically, starting from identifying the needs and problems in learning and then designing media concepts in accordance with the learning objectives (Atika & Sabina, n.d.).

Define (Analysis)

This definition stage is usually referred to as the needs analysis stage, which is useful for determining and defining the needs in the learning process and gathering various information related to the product to be developed (Sihombing, n.d.). In the initial analysis stage, it was found that students' interest in science subjects was still lacking. Therefore, the author developed an innovative learning medium that is able to attract students' interest, improve conceptual understanding, and encourage active involvement in the learning process. The next step was concept analysis to determine the content of the learning media developed, using material on growth and development in sprouts & electricity and magnetism for grade XI in accordance with the independent curriculum. Then, learning objective analysis was conducted to determine learning achievement indicators based on the analysis of the material and the LKPD that had been created. It is hoped that students will be able to understand the content of the learning media in depth and memorably.

Design

In this study, we developed a learning medium called grow and flow. Grow and flow is a learning medium made using styrofoam. The design of this learning medium on sprout growth and electric flow includes an attractive visual display, color selection, and placement of information components so that it is easy for students to understand. This media has a material presentation flow. The first is about the sequence of the sprout growth process. The second is about series and parallel electrical circuits. Grow and Flow is expected to be an easy-to-understand learning media that can explain the material to be conveyed and assist in the teaching and learning process.

Figure 1. Grow & Flow Learning Media

Figure 1 shows an image of the Grow and Flow learning media. This media is shaped like the letter L and made of styrofoam. This media contains integrated materials, namely sprout growth and electric current. For sprout growth, a sequence of epigeal germination processes is created, starting from the seed, root and stem growth, and the emergence of leaves. The sprouts are made using clay, which hardens so that they are not easily damaged. Then, in the electrical current material, there are two electrical circuits, namely series and parallel. The series circuit is placed in the title section, which applies the concept that if one light goes out, all the other lights will also go out, and if one light turns on, all the lights will also turn on. The parallel circuit is placed at the bottom of each sprout. In accordance with the concept, in a parallel circuit, if one light is turned off, the other lights will remain on. This parallel circuit is placed at the bottom to represent the light energy needed by plants to grow and perform photosynthesis.

With this approach, students not only understand the theory of seedling growth and photosynthesis, but also learn about the relationship between biology and physics through visual experiences. Learning using this learning medium combines real observation, analogy, and discussion, which will make it easier for students to understand abstract concepts in a fun way.

Development

To assess the feasibility of the Grow & Flow learning media before it is used in learning activities, a feasibility test is conducted first. The aspects assessed are media feasibility and material feasibility. The validators in the feasibility test of the Grow & Flow learning media consisted of four science teachers who acted as subject matter experts. The validation test was carried out by showing the Grow & Flow learning media to the validator teachers, accompanied by an explanation of the media and an evaluation instrument in the form of a validation sheet. After all the validation sheets were filled out by the validators, the data was processed. The evaluation results from the validators were then converted into data in the form of average scores. In addition, the evaluation results also included comments, suggestions, and recommendations for improvement from the validators, which were explained in detail as a basis for improving and perfecting the learning media. The following presents the data in the form of tables and diagrams based on the validation that has been carried out.

Table 2. Media Expert Validation Data

Assessment Aspects	Validator 1	Validator 2	Validator 3	Validator 4	Score
Material Suitability	4,33	4,66	4,66	4	4,4
Tool Durability	3,33	3,66	3,66	4,33	3,7
Tool Accuracy	5	5	5	5	5
Tool Efficiency	5	5	4	4,33	4,6
Aesthetics	4	5	4	4	4,2
Tool Safety	4	4,33	4,33	4,66	4,3
Total					4,4

Based on the results listed in the table, it can be seen that each assessment aspect received a high score with an overall average of 4.4. This shows that the Grow & Flow learning media is considered very suitable for use in learning activities. The highest score was in the aspect of tool accuracy, while the aspect of durability received the lowest score but still remained in the good category. To provide a clearer picture of the comparison between the assessment aspects, the validation results are visualized in the following bar chart.

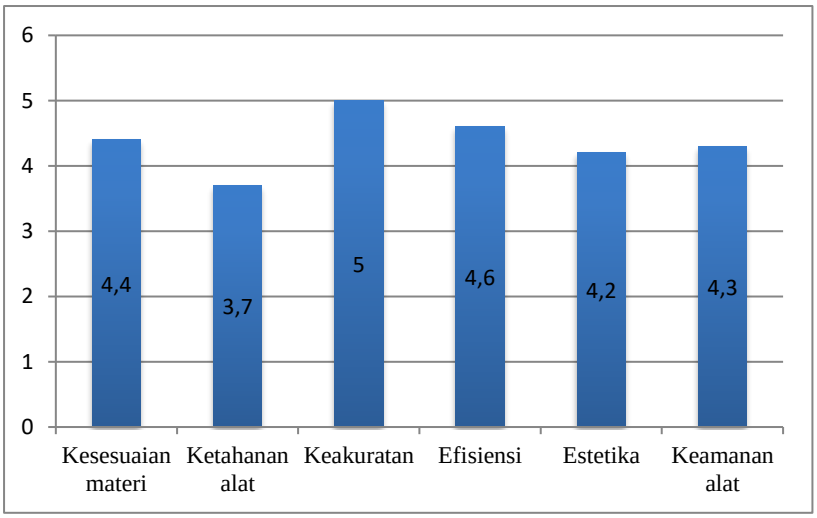

Diagram 1. Media Expert Validation Results

Based on the validation results from subject matter experts, there are six assessment indicators, namely material suitability, durability, accuracy, efficiency, aesthetics, and safety. The material suitability indicator has three assessment criteria with an average score of 4.4, which is classified as excellent. The durability indicator has three criteria with an average score of 3.7 and is classified as good. Furthermore, the accuracy indicator received a score of 5 with two criteria classified as excellent. The efficiency indicator has three criteria with a score of 4.6, which is also classified as excellent. The aesthetics indicator consists of one criterion with a score of 4.2, which is classified as excellent, and finally, the safety indicator received a score of 4.3 with the same category, namely excellent. Of the six assessment aspects, the highest score was in the accuracy aspect. In addition, there were comments or suggestions from subject matter experts who said that several improvements needed to be made to make the media more suitable and effective for use. It was recommended to add a user guide or work steps in the form of an instruction sheet so that the learning process would be more focused. Labels or markers should also be added to each component of the electrical circuit to help students

recognize the parts of the device and distinguish between series and parallel circuits. In addition, the media should use stronger, more durable, and waterproof materials so that they are not easily damaged or affected by dust and weather. Adjustments are also needed between the title, objectives, and content of the LKPD. In terms of design, the media can be made more attractive with neat colors and layout, while still paying attention to the safety of electrical cable use. Based on the six indicators assessed, the overall average score of 4.4 shows that the Grow & Flow learning media is in the excellent category. In addition to quantitative data obtained from questionnaires filled out by media experts, there is also qualitative data obtained from media experts' evaluations in the form of comments or suggestions for product revisions. Therefore, a descriptive analysis will be carried out to be used as material for revision in the refinement stage of this media. In general, the grow & flow learning media is considered creative and interesting and has great potential as a learning innovation according to the four validators. However, there are still some areas that need improvement to be more optimal and suitable for use in the learning process. To increase its effectiveness, the validators suggested adding usage guidelines in the form of instruction sheets and supporting tools such as detailed Student Worksheets (LKPD) and material handouts so that students can learn independently and understand the concepts thoroughly. The author has already added to the LKPD, but there was a suggestion from the validators that the content of the LKPD should cover all the material contained in the innovative media created.

In addition, from a physical perspective, it is emphasized that the containers used should be stronger with additional protection to maintain the durability of the media so that it is not damaged during transport, as well as increased safety by isolating electrical cables. The media must also be equipped with labels on electrical circuit components to distinguish between series and parallel electrical circuits, so that electrical concepts are easier to understand, as well as aesthetic additions to make it more attractive. By taking all of these suggestions into account, the grow & flow media is expected to become a more informative, safe, attractive, and effective science learning medium.

According to research conducted by Junaidi (2019), in choosing learning media, several important criteria need to be considered, such as the purpose of use, target users, media characteristics, time, cost, and availability. The purpose of using media will determine the type of media used, for example, real media, audio, still visuals, moving visuals, or audio-visuals. In addition, the media must be adapted to the conditions of the students so that learning can take place optimally. Each medium has certain advantages and limitations, so the selection of media needs to consider its suitability for the learning objectives to be achieved. The aspect of time is also a consideration, both in terms of the presentation of the media and the duration available for learning activities. In terms of cost, effectiveness and efficiency are key because simple and inexpensive media are not always less effective than expensive media. Finally, the availability factor also needs to be considered, namely media that is easily found in the surrounding environment, schools, or on the market. The creation of learning media requires skills, time, energy, and adequate facilities so that the results can be used optimally (Wulandari et al., 2023).

STEM education theory and constructivist learning principlesare closely related to the Grow and Flow innovation. This mediumcombines two major disciplines, namely biology and physics, in the context ofSTEM education by combining the ideas of seedling growth (grow) andelectric current (flow). This integration demonstrates the application of elements from the field of STEM education research: Science, Technology, Engineering, and Mathematics.Tarlochan et al. (2025) state that STEM education aims toimprove educational models that emphasize innovation and interdisciplinary connections. Students not only learn about the scientific process of seed germinationbut also learn about how series andparallel electrical circuits work. They can also measure things like plant growth time. Studentsare

encouraged to think and act like scientists and engineers through activitiesthat involve designing, observing, and analyzing experimental results. This helpsthem develop critical thinking, creativity, collaboration, andproblem-solving skills, which are the goals of modern education.

In addition, the Grow and Flow innovation is based on the principles of constructivist learning, which places students as active subjects in building their knowledge. Research supporting this principle shows that the constructivist approach allows students to actively participate in learning through their experiences and reflections, rather than just passively receiving information. In a study conducted by Akran & Sevim (2018), the constructivist approach was identified as the key to successful STEM education. Students have the opportunity to directly learn about the relationship between light intensity and plant growth through observation and experimentation in the Grow and Flow medium. Therefore, abstract ideas such as photosynthesis, electric current, and energy are transformed into concrete and meaningful learning experiences. Rather than being the primary source of knowledge, teachers function as facilitators who help students learn and think. This method encourages inquiry-based learning, where students formulate questions, learn on their own, and draw conclusions based on experimental results.

Thus, the Grow and Flow innovation reflects the application of constructivism in STEM education because it combines interdisciplinary learning with hands-on experiences that encourage students to think critically, creatively, and contextually in the real world. This combination makes learning more authentic, meaningful, and active, which is in line with the principles found in contemporary education literature.

CONCLUSION

This research produced an innovative learning medium called Grow & Flow, which combines the concept of seedling growth (biology) with series and parallel electrical circuits (physics). Its development used a 3D R&D model (Define, Design, Development) to create a contextual, interesting, and interactive medium for junior high school students.Based on the validation results from four experts, an average score of 4.4 was obtained, indicating that this media is very suitable for use in learning activities. The highest score was given to the accuracy of the tools, while the durability of the media still needs improvement. The validators also recommended adding usage guidelines, labels on components, and selecting more sturdy and safer materials. Overall, the Grow & Flow media is considered innovative, interesting, and effective in improving students' understanding of concepts, creativity, and involvement in integrated science learning. For further development, it is recommended that effectiveness tests be conducted in the classroom and interactive features be added so that this media is more in line with the demands of 21st-century learning.

THANK YOU

The author would like to express his gratitude to Mrs. Rahmi Faradisya Ekapti, M.Pd. as the lecturer who has provided guidance, direction, and support during the research process and the writing of this article. Through her guidance, the author has gained valuable insights and input in the development of the Grow & Flow learning media. The author would also like to express his deepest gratitude to the science teachers who served as expert validators and played an important role in the learning media validation process. They took the time to assess, provide criticism, and offer constructive suggestions for the improvement of the Grow & Flow media. The support and cooperation of all parties involved played an important role in the success of this research. May the results of this research be beneficial to the world of education, particularly in the development of innovative and meaningful science learning media.

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