JPPIPA 11(10) (2025)

Jurnal Penelitian Pendidikan IPA

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

Digital Media-Based Scientific Approach to Improve Learning Motivation and Content Creation Skills of Prospective Biology Teachers at Universitas Cenderawasih

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Received: July 15, 2025
Revised: September 29, 2025
Accepted: October 25, 2025
Published: October 31, 2025

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DOI: 10.29303/jppipa.v11i10.12164

Abstract: This study aimed to investigate the implementation of a Scientific Approach based on digital media to improve learning motivation and digital content creation skills among prospective biology educators at Cenderawasih University. The research used a pre-experimental design with a one-group pretest-posttest model. A purposive sampling technique was used, involving 22 students of the Biology Education Study Program. The study was grounded in the challenges of 21st-century education, which requires future teachers to master both pedagogical skills and digital literacy to deliver content creatively, contextually, and effectively. The Scientific Approach was applied through stages integrated with digital media tools such as Canva, CapCut, and video editors. The findings revealed a significant improvement in students' learning motivation, supported by the Paired Sample t-Test and an N-Gain score of 0.56, indicating a moderate category. Students showed increases in value, expectancy, and affective components of motivation due to the interactive and engaging learning experience. Additionally, their ability to create digital content improved, with an average rubric score of 85.60, categorized as good. These results suggest that a Scientific Approach enriched with digital media can serve as an effective learning strategy to enhance both motivation and digital competence among future biology teachers. The model is recommended for broader adoption in teacher education institutions in response to the Merdeka Belajar initiative and the demands of the Industrial Revolution 4.0.

Keywords: Digital content creation; Digital media; Learning motivation; Scientific approach

Introduction

The development of digital technology has brought significant changes to the world of education, including the learning process in higher education. Prospective biology educators, as part of the digital native generation, are faced with the challenge of not only conceptually understanding teaching materials but also possessing the ability to deliver learning in an engaging, interactive, and relevant manner to the 21st-century context (Espejo et al., 2022; Nurbaya, 2024a, 2023; Prensky, 2001). One learning approach that aligns with the characteristics of science and has been implemented in the national curriculum is the Scientific Approach. This approach emphasizes five main stages: observing, asking, experimenting, reasoning, and communicating (Hosnan, 2014; Setiawan, 2020). Unfortunately, in practice, this scientific approach is often implemented conventionally without adequate digital media integration, thus failing to stimulate student learning

How to Cite:
Nurbaya, N., Listiani, H., Satar, S., Akobiarek, M., & Lemauk, K. M. (2025). Digital Media-Based Scientific Approach to Improve Learning Motivation and Content Creation Skills of Prospective Biology Teachers at Universitas Cenderawasih. *Jurnal Penelitian Pendidikan IPA*, *11*(10), 79–87. https://doi.org/10.29303/jppipa.v11i10.12164

motivation and creativity in the learning process (Al Hashimi et al., 2019; Sadulla, 2024).

Another emerging issue is the low motivation of prospective teachers to produce educational and contextual digital content (Désiron et al., 2025). However, the ability to create digital learning content is crucial in the context of Independent Learning, which encourages teachers to become facilitators and learning innovators (Kemendikbudristek, 2020). Digital content creation skills require not only technological mastery but also pedagogical understanding and the ability to present biology material visually and communicatively (Agbo, 2015; Koehler & Mishra, 2009; Redecker, 2017; Tanta et al., 2023). The lack of training that combines a scientific approach with the use of digital media means that prospective educators are not yet optimally trained in developing technology-based teaching materials that support learning outcomes (Funke et al., 2025; Grassinger et al., 2022).

The focus of the research is directed at the application of a learning model that not only strengthens the mastery of biological concepts through a scientific approach, but also encourages students to produce innovative and meaningful digital learning content. In addition, this study also aims to measure the extent to which this approach is able to increase students' learning motivation, as one indicator of their readiness to become professional educators who are adaptive to changing times (OECD, 2018). The urgency of this research lies in the strategic need to produce future biology teachers who are not only academically competent, but also creative, technology literate, and competitive in the digital education ecosystem.

This research supports the government's digital transformation policy in education and addresses the challenge of low technology integration in science learning at the higher education teacher training level. Through this research, it is hoped that a learning model can be developed that can be replicated in other education courses and make a real contribution to strengthening the digital and pedagogical competencies of prospective biology teachers in Indonesia. Based on this background, the researcher chose the research title "The Application of a Digital Media-Based Scientific Approach to Learning Motivation and Digital Content Creation of Prospective Biology Teachers at Cenderawasih University."

Method

This study uses a quantitative approach with a pre-experimental design in the form of a one-group pretest-posttest design. The population was all students in the Biology Education Study Program, FKIP Cenderawasih University, totaling 350 people. Sampling was carried out by purposive sampling by considering the characteristics of the experimental class. The sample selected was 22 students from the Class of 2022, Class A in the Biology Learning Curriculum Review course. Students from the Class of 2022, Class A are currently taking relevant education courses (Biology Learning Curriculum Review and Biology Learning Strategies) so that they are a suitable group to be given the application of the Scientific Approach based on digital media. Thus, they are in the appropriate lecture phase to develop learning motivation as well as digital content creation skills.

Data collection techniques adapted to the variables studied and the quantitative approach used are learning motivation questionnaire, digital content creation assessment rubric, and learning activity observations. Learning Motivation Questionnaire was developed based on Pintrich & De Groot's learning motivation theory (1990), covering aspects of value, expectancy, and affective components. This instrument uses a 4-point Likert scale, ranging from strongly disagree (1) to strongly agree (4). The content validity of the questionnaire will be tested through expert assessment (validators) and pilot testing on a similar sample to measure reliability using the Cronbach's Alpha formula.

Digital content creation assessment rubric used to measure students' ability to create digital content based on aspects of digital literacy and creativity. The rubric includes the following indicators: 1) Originality of ideas, 2) Relevance to the biology learning topic, 3) Integration between text, images, and media, 4) Use of digital tools (Canva, video editors, etc.), 5) Clarity of message and visual appeal. As for learning activity, Observations are used as supporting data to monitor student active engagement during the learning process. The observation format is developed in the form of a structured observation sheet, which includes indicators such as: 1) Participation in discussions, 2) Ability to respond to questions argumentatively, 3) Involvement in digital collaborative tasks, and 4) Initiative to use digital media independently. For educational research or classroom action research, clearly describe the instrument that was built and its use. The author must be able to explain how the instrument is given. For Science research, the author can replace the subheadings according to need such as Extraction, Isolation Method, and Test Sample.

This research was designed in four main, interconnected stages to systematically achieve the research objectives. The first stage was instrument preparation and development, which was carried out in the first to second months. In this stage, researchers conducted a literature review to strengthen the theoretical basis, developed learning tools based on the Scientific Approach, and designed digital media to

support learning. Furthermore, research instruments such as learning motivation questionnaires and digital content assessment rubrics were developed and validated by experts. The outputs of this stage included validated learning tools, ready-to-use digital media, and valid and reliable research instruments. The indicator of success at this stage was achieving a minimum level of instrument content validity of 85% based on expert assessment results.

The second stage is the implementation of learning, which is carried out in the third to fourth months. The core activities at this stage involve the implementation of learning in the experimental and control classes for 6 to 8 meetings. During the implementation, researchers observe the learning process and collect initial data (pretest) and final data (posttest) on both learning motivation and students' digital work results. The output of this stage is raw data that reflects changes in learning motivation and the quality of digital content produced by students. The targeted achievement indicators are student attendance rates exceeding 90% and completion of digital assignments by at least 80% of participants. The writing of research procedures are written in paragraph form. The research procedure is not written in numbering but in paragraph form.

The data analysis and interpretation phase was carried out. In this phase, researchers processed the collected quantitative data using parametric statistical techniques, such as t-tests and normalized gain (N-gain) calculations, to determine the effectiveness of the treatment on the dependent variable. The results of this phase are expected to show a significant increase in students' learning motivation and digital skills. Furthermore, researchers also interpreted the pedagogical meaning of these findings. The indicator of success in this phase is the achievement of results showing an increase with a significance level of $p < 0.05$, indicating that the treatment provided had a significant impact on the variables studied.

The data analysis techniques in this study were adapted to the type of data obtained from the learning motivation questionnaire instrument, digital work assessment rubric, and observation sheets. Before conducting inferential analysis, the data were first tested to meet parametric statistical assumptions through a normality test using the Kolmogorov-Smirnov and a homogeneity of variance test using Levene's Test. Analysis of the effect of treatment on learning motivation was conducted using a paired sample t-test to determine the difference in pretest and posttest scores in the experimental group, as well as an N-Gain score analysis to measure the effectiveness of the treatment in increasing motivation relatively. Meanwhile, digital content creation skills were analyzed quantitatively descriptively to describe the distribution of rubric scores for students' work, and qualitatively descriptively to identify prominent aspects of digital work, such as creativity, design characteristics, and the use of digital tools in the creation process. Research procedure can be seen on Figure 1.

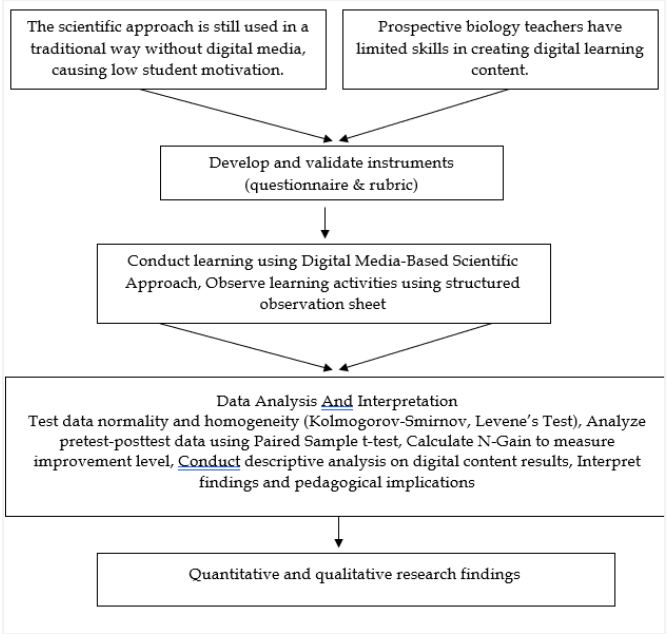

Figure 1. Research procedure

Result and Discussion

The normality test and homogeneity test aim to ensure that the data used meets parametric statistical assumptions so that further analysis can be carried out appropriately. Normality testing was performed using the Kolmogorov-Smirnov test on student learning motivation data both before (pretest) and after treatment (posttest). The test results showed a significance value of 0.134 ($p > 0.05$), indicating a normal distribution of the data. This means there are no significant deviations from the distribution of the data, so it can be used in parametric statistical tests. The results of the normality test on the learning motivation data of prospective biology educators before and after treatment are presented in Table 1.

Table 1. Normality Test

Variable	Interpretation	Sig. (p-value)
Learning Motivation	Data is normally distributed	0.134

A homogeneity of variance test was conducted to determine whether the data had uniform variance across measurement groups. The test was conducted using Levene's Test, which yielded a significance value of 0.271 ($p > 0.05$). This result indicates that the data variance between learning motivation scores before and

after treatment was homogeneous or equal. Homogeneity of variance is an important requirement for the results of the paired sample t-test to be interpreted correctly and validly. This test used Levene's Test with a significance level of 5%. The results of the homogeneity test are presented in Table 2.

Table 2. Homogeneity Test

Variable	Levene's Test Sig.
Learning Motivation	0.271

These two results provide a strong basis for confirming that the research data meets the criteria for parametric analysis. By meeting the assumptions of normality and homogeneity of variance, further analyses such as paired sample t-tests, independent sample t-tests, and N-Gain analysis can be conducted without concern for bias or violation of statistical assumptions. This supports the reliability and validity of the overall research findings.

Analysis of Learning Motivation after Implementing a Digital-Based Scientific Approach

A paired sample t-test analysis was conducted to determine significant differences between students' learning motivation scores before and after treatment. The following table shows the calculation of the paired sample t-test.

Table 3. Paired Sample t-Test Result

Parameter	Mean Pretest	Mean Posttest	Mean Difference	t	p-value	Interpretation
Learning Motivation	60.80	82.70	21.90	11,578	0.000	Significant (there is an increase)

The results show that the average student learning motivation score before treatment (pretest) was 60.80, while after treatment (posttest) it increased to 82.70. The average difference value (mean difference) of 21.90 indicates a significant increase. The t-test produced a t-value of 11.578 with a p-value of 0.000 ($p < 0.05$). Thus, there is a significant difference between the student learning motivation scores before and after the implementation of the digital media-based Scientific Approach. These results support the research hypothesis that the implementation of a digital media-based scientific approach can significantly increase the learning motivation of prospective biology teachers. The motivation score increased significantly, indicating that students felt more motivated and interested in the interactive and technology-based learning process.

N-Gain analysis is used to see the effectiveness of treatment in increasing student learning motivation relatively. The following table shows the result of N-Gain score.

Table 4. N-Gain Result

Pretest Score	Posttest Score	Maximum Score	N-Gain	Category
60.80	82.70	100	0.56	Medium

The increase in learning motivation of prospective biology teachers after the implementation of the digital media-based Scientific Approach is classified as moderate, based on an N-Gain value of 0.56 (Table 4). This means that this intervention is quite effective in fostering students' interest, enthusiasm, and enthusiasm for learning biology materials and digital-based learning practices. This indicates that students feel more challenged, more active, and more confident in participating in learning that integrates digital media with a scientific approach. Although the results are positive, this moderate value also indicates that there is still room for further strengthening. For example, intensive mentoring or guidance can help students who are still having difficulty adapting to digital technology, especially in the digital content creation stage. In addition, variations in other digital media such as the use of augmented reality, virtual labs, or interactive simulations can be considered to enrich the learning experience, thereby facilitating a more diverse learning style (Sapriati et al., 2023).

The application of the Scientific Approach (observing, asking, trying, reasoning, and communicating) combined with the use of digital media provides a more active, meaningful, and contextual learning experience (Hosnan, 2014; Nurbaya, 2024b; Suyanti & Dian, 2022). Students are directly involved in the process of searching, processing, and presenting information using digital media. This process fosters a heightened sense of curiosity and encourages students to participate voluntarily in learning activities (Liu et al., 2024; Nagel et al., 2020). The value aspect of learning motivation, which relates to students' perceptions of the importance of the material and learning, increased because students saw the relevance of using digital technology in their future professional teaching roles (Redecker, 2017). The expectancy aspect, which relates to self-confidence in successfully completing assignments, also increased because students felt more capable of mastering the material with the help of attractive digital media. Meanwhile, the affective aspect, namely enjoyment and comfort while learning, was also

encouraged thanks to the interactive and diverse learning environment.

These findings are consistent with the Self-Determination Theory framework, which emphasizes the role of autonomy, competence, and connectedness in fostering intrinsic motivation (Ryan & Deci, 2000). Through the digital-based Scientific Approach, students feel empowered to express themselves creatively, empowered to take initiative, and receive interactive feedback. The use of digital media such as Canva, CapCut, and other supporting applications facilitates students in presenting learning ideas in a more visual, engaging, and easy-to-understand manner (Ekowati et al., 2024; Sinaga et al., 2025). This technology integration enriches the learning experience while expanding students' digital literacy, which in the 21st-century learning era has become a key competency for teachers (Redecker, 2017). However, the moderate motivational achievement also indicates the need for further optimization. For example, strengthening mentoring or intensive guidance is needed to better facilitate students who lack confidence in using technology. Furthermore, diversifying other, more interactive digital media, such as virtual simulations, augmented reality, or game-based learning, can be used as additional innovations to increase learning motivation to a higher level (Silvi, 2022).

Overall, the Scientific Approach-based learning supported by digital media has been proven to increase the learning motivation of prospective biology teacher students at Cenderawasih University. These results contribute positively to the effort to prepare prospective biology teachers who not only master the material but are also ready to adapt to future developments in educational technology. Therefore, this learning model can be adopted more widely in other education courses as one of the curriculum innovation strategies of LPTK (Teachers' Training Institute) to face the challenges of the 21st century.

Analysis of Digital Content Creation Capabilities after Implementing a Digital-Based Scientific Approach

The assessment of students' ability to produce digital learning works was analyzed using quantitative and qualitative descriptive approaches. Quantitatively (Table 5), the average score for students' digital works after the treatment was recorded at 85.60 with a standard deviation of 5.20. This score is categorized as good, indicating that students are capable of designing and producing digital-based learning content that is relevant, communicative, and adaptive to the characteristics of biology material.

The assessment aspects measured in the rubric include originality of ideas, suitability to biological material, integration of text, image, and media elements, use of digital tools, and clarity of message and visual appeal. The average results of each aspect indicate that students have adequate abilities in all indicators, with the following details: originality of ideas (87, good category), suitability of material (84, good category), integration of text, images, and media (85, good category), use of digital tools (86, good category), and clarity of message and visual appeal (85, good category).

Table 5. Assessment of Digital Media

Assessment Aspects	Average Score	Category
Originality of ideas	87	Good
Suitability of materials	84	Good
Integration of text, images, and media	85	Good
Use of digital tools	86	Good
Clarity of message and visual appeal	85	Good
Average score	85,60	Good

Figure 2. Result of students' digital content creation

The descriptive qualitative analysis revealed that students were not only capable of creating engaging content but also demonstrated high creativity in highlighting contextual illustrations that supported the biology material. Several works showcased the use of concise and informative infographics, short animations, and instructional videos that combined narrative with communicative visuals. Students utilize various digital applications such as Canva, CapCut, and other video

editing apps to enhance the quality of their presentations. Collaboration among students is also observed to be running smoothly, as evidenced by the work produced in groups with a clear and structured division of tasks (Ekowati et al., 2024; Yuniawati & Priyana, 2024). This is one indicator that the digital media-based Scientific Approach learning program not only improves students' technical competency in content creation but also strengthens soft skills such as collaboration, communication, and innovation (Bilici & Yilmaz, 2024; Shadiev et al., 2022).

These findings reinforce the conclusion that the Scientific Approach learning intervention, integrated with digital media, is worthy of recommendation as a learning innovation model in educational programs at Cenderawasih University and other universities. This is because it has been proven to develop learning motivation and encourage students to produce digital learning projects that are meaningful, contextual, and aligned with 21st-century needs.

Observation data of student learning activities were analyzed descriptively quantitatively by calculating the percentage of achievement in each indicator, namely participation in discussions, argumentation skills, collaboration in digital assignments, and initiative to use digital media independently. Overall, the achievements in these four learning activity indicators indicate that learning with a digital media-based Scientific Approach can create a participatory, collaborative learning environment and motivate students to actively innovate. These observational findings confirm that a digital media-based scientific approach not only impacts learning motivation and digital skills of students, but also contributes to strengthening active attitudes, self-confidence, and a collaborative spirit in the learning process (Dewi & Primayana, 2019; Nurbaya et al., 2025; Wahab et al., 2024). Learning based on the Scientific Approach integrated with digital media can be recommended to support the achievement of the profile of a 21st-century teacher who is adaptive, creative, and technologically literate (Asrizal et al., 2022; Ekici & Erdem, 2020; Rintaningrum, 2023).

The results of the study indicate that the ability of prospective biology educator students to create digital learning content improved after implementing the Scientific Approach learning approach based on digital media. The average score for the assessment rubric for students' digital work was 85.60 (good category), indicating that students were able to apply creativity, digital literacy, and pedagogical skills in an integrated manner to produce learning content. The application of the Scientific Approach in learning scenarios encourages students to go through the stages of observing, asking questions, experimenting, reasoning, and communicating learning ideas (Afrianto, 2017; Bramastia & Rahayu, 2023). These stages stimulate critical thinking while simultaneously designing concrete learning solutions, including through the creation of digital media (Setiawan, 2020). Students are encouraged not only to understand the biology content but also to convey it in an engaging, interactive, and contextual manner by utilizing various digital platforms such as Canva, CapCut, and other video editing applications (Cai et al., 2017).

The students' originality was assessed as good, as reflected in the content themes relevant to biology learning topics, packaged with creative visualizations, and tailored to the characteristics of junior high school students. The integration of text, images, sound, and interactive media also demonstrated a fairly good level of integration, indicating that students understood the principles of instructional design in digital learning media (Wiyanah & Rahman, 2024). Qualitative descriptive analysis revealed prominent characteristics in the students' work, including the use of contextual illustrations appropriate to local Papuan culture, the use of animated videos as learning stimuli, and the presentation of content that was easily accessible and understood by students. Furthermore, students demonstrated the ability to collaborate in developing digital content in groups, sharing roles as editors, narrators, and graphic designers, which aligns with the demands of collaborative competencies in 21st-century learning (Redecker, 2017).

The research findings revealed that the digital-based Scientific Approach not only supports the achievement of biology competency but also provides students with the opportunity to innovate by creating relevant, creative, and contextual learning content. This finding aligns with Taylor (2020) and Cortez et al. (2024) finding that the ability to create digital content is a crucial component of 21st-century digital literacy, a must-have for today's prospective teachers. Although digital content creation skills were in the good category, the study also recommended further training to deepen the use of more complex learning technologies, such as augmented reality applications, virtual laboratory simulations, or gamification (Zainuddin, 2020). Mastery of these advanced technologies can further enrich the variety of learning media and support the differentiation of teaching strategies in the classroom.

It can be concluded that the digital-based Scientific Approach has proven effective in improving the skills of prospective biology educators in designing, developing, and presenting high-quality digital learning content. This achievement is expected to contribute to strengthening the capacity of prospective teachers in the era of Independent Learning and the Industrial Revolution 4.0, which requires educators to be

facilitators, innovators, and creators of adaptive digital learning content.

Conclusion

The learning motivation of prospective biology educators after implementing the digital-based Scientific Approach experienced a significant increase. This is evident from the learning motivation questionnaire score, which significantly increased after the treatment, with an N-Gain of 0.56, which is considered moderate. The digital-based scientific approach facilitates students' active participation, engaging in the learning process independently, creatively, and collaboratively, thereby enhancing their perceived value, expectations, and affection for biology learning. The digital content creation skills of prospective biology educators also demonstrated positive results after implementing this learning approach. The average score for students' digital product assessments was 85.60, which is considered good, reflecting their success in designing original, relevant, and integrated biology learning content that optimally utilizes digital technology. Students were able to combine text, images, videos, and other supporting applications to create communicative and engaging learning media for students.

Acknowledgments
The author would like to thank the Head of the Biology Education Study Program at Universitas Cenderawasih for their support in this research.

Author Contributions
Conceptualization, N.N; methodology, N.N, H.L.; validation, SS., M.A. and K.A.; formal analysis, N.N.; writing—original draft preparation, N.N.; writing—review and editing, N.N.; visualization, S.S.; supervision, M.A.; project administration, H.L, and K.A. All authors have read and agreed to the published version of the manuscript.

Funding
This research was funded by DIPA FKIP PNBP BLU Universitas Cenderawasih Year 2025.

Conflicts of Interest
The authors declare no conflict of interest.

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