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# Development of a thinking actively in a social context (TASC)-based digital worksheet ecosystem (DWE) to improve creative thinking ability

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**Abstract**

Digital Worksheet Ecosystem (DWE) based on TASC (Thinking Actively in Social Context) was developed as an innovative learning media to facilitate understanding of ecosystem material interactively and contextually. This study aims to develop DWE and analyze its feasibility and influence on students' creative thinking skills. The research method uses the Hannafin and Peck development model consisting of needs analysis, design, and development and implementation, followed by evaluation and revision at each stage. The results of expert validation showed that DWE is very valid and feasible to use as a biology learning media. The results of the test percentage of creative thinking skills in the experimental class and the highest control class in the ability of flexible thinking indicators (experimental), the experimental class at 98.5% and the control class at 90.5%, while in the experimental class the lowest value on the original thinking indicator (originality) equal to 55.00% and the control class on the original thinking indicator (originality) of 46.5%. The results showed that the average value of the ability to think creatively in the experimental class scored 76.94 while the control class scored 68.02. The implementation of DWE showed a significant improvement in students' creative thinking skills in terms of fluency, flexibility, originality, and elaboration. These findings indicate that TASC-based DWE is effective in improving students' creative thinking skills in biology learning.

***Abstrak.*** *Ekosistem Lembar Kerja Digital (DWE) yang didasarkan pada Tasc (Berpikir Aktif dalam Konteks Sosial) dikembangkan sebagai media pembelajaran inovatif untuk memfasilitasi pemahaman materi ekosistem secara interaktif dan kontekstual. Penelitian ini bertujuan untuk mengembangkan DWE dan menganalisis kelayakan serta pengaruhnya terhadap keterampilan berpikir kreatif siswa. Metode penelitian menggunakan model pengembangan Hannafin dan Peck yang terdiri dari analisis kebutuhan, desain, pengembangan, dan implementasi, diikuti dengan evaluasi dan revisi pada setiap tahap. Hasil validasi ahli menunjukkan bahwa DWE sangat valid dan layak digunakan sebagai media pembelajaran biologi. Hasil persentase kemampuan berpikir kreatif pada kelas eksperimen dan kelas kontrol tertinggi dalam indikator kemampuan berpikir fleksibel (eksperimen), kelas eksperimen sebesar 98,5% dan kelas kontrol sebesar 90,5%, sementara pada kelas eksperimen nilai terendah pada indikator pemikiran asli (originalitas) sebesar 55,00% dan kelas kontrol pada indikator pemikiran asli (originalitas) sebesar 46,5%. Hasil menunjukkan bahwa nilai rata-rata kemampuan berpikir kreatif di kelas eksperimen sebesar 76,94 sementara kelas kontrol sebesar 68,02. Penerapan DWE menunjukkan peningkatan yang signifikan dalam keterampilan berpikir kreatif siswa dalam hal kelancaran, fleksibilitas, keaslian, dan elaborasi. Temuan ini menunjukkan bahwa DWE berbasis TASC efektif dalam meningkatkan keterampilan berpikir kreatif siswa dalam pembelajaran biologi.*

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# A. Introduction

In the 21st-century education era, creative thinking skills are an essential aspect that must be developed in the learning process. One of the required competencies in 21st-century learning is no longer limited to the ability to read and memorize, as is still commonly found in many schools in Indonesia (Hobri et al., 2019). The younger generation needs to master critical thinking, creative thinking, and problem-solving skills for everyday life (Anwar et al., 2022). Twenty-first-century learning is designed based on technological advancements and the demands of the Industrial Revolution 4.0, with the aim of equipping students with relevant life skills. One of the core approaches is the mastery of 4C skills (Critical Thinking, Communication, Collaboration, and Creativity) (Ni'mah & Sukartono, 2022). The 4C skills play a crucial role in the learning process as they enable students to work collaboratively in groups to solve problems, foster tolerance for differing opinions, and enhance creativity in seeking solutions by connecting various aspects of everyday life (Abdullah et al., 2022). Creative thinking skills are essential for students in understanding the concept of ecosystems as a foundation for solving environmental problems. An ecosystem is a system consisting of interactions between living organisms (biotic) and the physical environment (abiotic) within a specific area. It includes various components such as producers, consumers, decomposers, and environmental factors like soil, water, and sunlight that support life.

Many students have misconceptions or difficulty understanding ecosystem concepts, mainly due to the abstract and complex nature of the material, such as: Complex Reciprocal Relationships: Difficulty understanding the dynamic, interdependent interactions between biotic (producers, consumers, decomposers) and abiotic (soil, water, sunlight) components (Hanifah et al., 2022); and Energy Flow and Material Cycle: This concept is difficult to imagine through lectures and textbooks alone. Learning that is dominated by lectures and passive delivery of material (such as PowerPoint or files) often makes students bored and passive. This reduces their motivation to find out more about the material (Susanti et al., 2024).

Ecosystem material requires analytical skills (e.g., the impact of changes in biotic components on the entire system) and the application of concepts to everyday problems (e.g., environmental pollution or conservation issues). These issues are often not explored if students are not presented with challenging situations (Haya et al., 2025).

One approach that can be applied to enhance these skills is the TASC (Thinking Actively in a Social Context) learning model. The TASC model is designed to develop students' ability to think actively in a social context through a series of systematic thinking stages. This approach not only encourages creative problem-solving but also strengthens interaction within the learning process. In practice, TASC-based learning is still rarely developed in the form of teaching materials that meet students' needs. Learning activities require new innovations from educators to make lessons more engaging and aligned with students' needs. The learning process demands interactive, innovative, and efficient learning models and media to make learning more meaningful, particularly in biology education (Lestari et al., 2023).

Therefore, the development of a TASC-based Digital Worksheet Ecosystem (DWE) is a potential innovation to enhance the quality of learning. DWE not only provides flexibility in the learning process but can also be designed interactively to stimulate students' creative thinking skills.

TASC aims to teach students to think analytically in solving their own problems and to convey what they have learned to other students in a contextual manner. Through TASC-based DWE learning resources, students are taught how to analyze and develop creative ideas in addressing problems around them. TASC provides practice in thinking skills and problem- solving strategies, such as in waste management. One of the thinking skills that can be developed through TASC is creative thinking (Rosidi, 2017).

The implementation of a TASC-based DWE must be supported by the use of appropriate and relevant learning resources. Learning resources can be defined as anything that can be used and utilized in the learning process to achieve learning objectives. DWE is a learning medium used by teachers to facilitate students' learning activities in electronic form, accessible via computers, laptops, and mobile phones (Syafitri & Tressyalina, 2020). DWE can improve students' technological skills and minimize paper usage in learning. Furthermore, DWE is expected to foster effective interaction between students and teachers, thereby enhancing student engagement and academic achievement (Ekasari et al., 2021).

Previous research has demonstrated that the use of TASC-based worksheets can enhance creative thinking skills, particularly in the dimensions of fluency, flexibility, originality, and elaboration (Rosidi, 2017). The present study aims to develop a TASC-based Digital Worksheet Ecosystem (DWE) for the ecosystem topic to foster students' creative thinking skills. It is anticipated that this development will result in more effective instructional materials that align with the demands of 21st-century education.

The results of this study are expected to produce a TASC-based DWE learning medium that is valid, feasible, and practical for use in biology education. In addition, the implementation of DWE is expected to enhance students' creative thinking skills, enabling them to be better prepared to face complex

environmental issues in the future. This research is also expected to serve as a reference for teachers, researchers, and education practitioners in developing relevant and effective technology-based learning media.

## B. Material and method

This study employed a research and development (R&D) approach using the Hannafin and Peck model, which consists of three main stages: (1) needs analysis, (2) design, and (3) development–implementation, with evaluation and revision conducted at each stage with indicators of creative thinking ability; (1) fluency, (2) flexibility, (3) originality, and (4) elaboration. The research was carried out at SMAS Yadika 10 Kosambi, involving 70 tenth-grade students as trial subjects, divided into an experimental group (35 students) and a control group (35 students). The sample selection used purposive sampling based on academic ability and availability of supporting facilities.

Data were collected through a needs analysis questionnaire, expert validation sheets (covering material, media, and language aspects), and a creative thinking skills test instrument encompassing relevant indicators (Irmaya & Sunarti, 2020). The test instrument was validated by four experts in biology education and its reliability was assessed using Cronbach's Alpha coefficient ($\alpha > 0.7$). Expert presentation, language, and graphical design, with a minimum score criterion of ≥ 3.25 on a 4-point scale (Batubara, 2021).

The implementation of the Digital Worksheet Ecosystem (DWE) was conducted over four weeks using a pretest–posttest design with a control group. Data were analyzed quantitatively using descriptive and inferential statistics, including the Kolmogorov–Smirnov normality test, Levene's homogeneity test, outlier analysis, linearity test, and MANOVA test.

## C. Results and discussion

The development of the TASC-based Digital Worksheet Ecosystem (DWE) was carried out using the Hannafin and Peck model, which comprises three main stages: needs analysis, design, and development–implementation. The Needs Analysis stage aims to obtain preliminary information about biology learning conducted by biology educators and students. This activity is carried out by distributing needs analysis questionnaires to students and biology educators. Student Needs Analysis is the first step in developing this DWE. As many as 74% responded that the learning resources they usually use to supplement their information come from websites such as Brainly, Wikipedia, and blogs. 60% of students responded that they were accustomed to using smartphones to assist in the learning process, while several other students believed that 20% of students used printed worksheets/biology textbooks in the learning process.

The analysis of educators' needs found that there are difficulties in teaching biology, one of which is the ecosystem material because students often misunderstand it, for example, in distinguishing between food chains and food webs that occur in ecosystems. Another difficulty is that students are still not thorough in analyzing tasks or questions in the form of case studies given to them.

The design was created by developing a clear and detailed product framework containing the appearance of materials, videos, and content to be developed in the creation of learning media (Figure 1). The concept design used a storyline based on the components contained in the DWE.

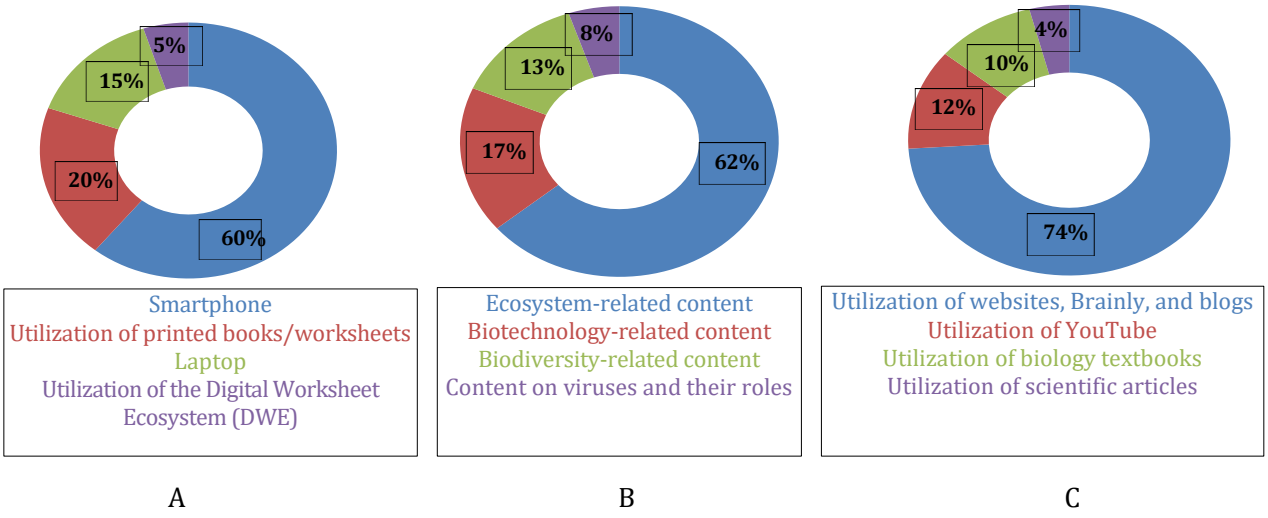


Figure 1
Results of the students' needs analysis: a) percentage of learning media usage; b) percentage of biology topics perceived as difficult; c) percentage of learning resource utilization.

**Table 1 Results of percentage calculation of each aspect in media feasibility test**

| Media expert | Percentage obtained media feasibility test aspect | | | Average |
|---|---|---|---|---|
| | Texts | Image | Display | |
| 1 | 82.00% | 85.00% | 91.00% | 86.00% |
| 2 | 85.00% | 88.00% | 93.00% | 88.00% |
| 3 | 78.00% | 78.00% | 78.00% | 78.00% |
| 4 | 90.00% | 88.00% | 82.00% | 86.00% |
| **Average** | **83.00%** | **84.00%** | **86.00%** | **84.00%** |

**Table 2 Results of the percentage calculation of each aspect in the material feasibility test**

| Material expert | Media experts' percentage aspect of material feasibility test average | | Average |
|---|---|---|---|
| | Material | Teaching | |
| 1 | 90.00% | 93.00% | 91.00% |
| 2 | 85.00% | 88.00% | 86.00% |
| 3 | 85.00% | 89.00% | 87.00% |
| 4 | 79.00% | 78.00% | 78.00% |
| **Average** | **84.00%** | **87.00%** | **85.00%** |

**Table 3 Results of percentage calculation of each aspect in the eligibility test by biology teachers**

| Biology teacher | Trial aspect by teacher | | | | Average |
|---|---|---|---|---|---|
| | Material | Presentation | Language | Benefits | |
| 1 | 82.00% | 88.00% | 88.00% | 85.00% | 85.00% |
| 2 | 90.00% | 86.00% | 95.00% | 79.00% | 87.00% |
| **Average** | **86.00%** | **87.00%** | **91.00%** | **82.00%** | **86.00%** |

**Table 4 Results of the calculation of the average percentage of each aspect in the small and large group trial instrument**

| Biology teacher | Percentage value of trial aspect | | | | Average |
|---|---|---|---|---|---|
| | Material | Presentation | Language | Benefits | |
| Smallgroup | 90.00% | 92.00% | 91.00% | 94.00% | 91.00% |
| Largegroup | 92.00% | 94.00% | 91.00% | 92.00% | 92.00% |
| **Average** | **91.00%** | **93.00%** | **91.00%** | **93.00%** | **92.00%** |

**Table 5 Descriptive analysis of creative thinking ability**

| **Indicators** / **Class** | | N | Average | Minimum score | Maximum score | D | Gain score |
|---|---|---|---|---|---|---|---|
| Digital worksheet ecosystem (DWE) | Prestest | 35 | 38.28 | 20.00 | 62.00 | 9.52 | 0.70 |
| | Posttest | 35 | 81.48 | 58.00 | 96.00 | 8.67 | |
| Printed LKPD | Prestest | 35 | 36.02 | 20.00 | 60.00 | 9.01 | 0.47 |
| | Posttest | 35 | 67.54 | 50.00 | 80.00 | 8.27 | |

**Table 6 Average of creative thinking ability test indicators**

| | Experimental class DWE | | | | Control class printed LKPD | | | |
|---|---|---|---|---|---|---|---|---|
| **Indicator** | **n** | **Pretest Mean (±SD)** | **Posttest Mean (±SD)** | **N-Gain (category)** | **N** | **Pretest Mean (±SD)** | **Posttest Mean (±SD)** | **N-Gain (category)** |
| Fluency | 35 | 50.05 (±7.15) | 58.75 (±10.05) | 0.35 (Medium) | 35 | 48.15 (±7.08) | 50.75 (±9.04) | 0.30 (Medium) |
| Flexibility | | 67.45 (±10.25) | 98.50 (±19.65) | 0.69 (Medium) | | 68.55 (±11.06) | 80.00 (±12.75) | 0.50 (Medium) |
| Originality | | 50.00 (±6.03) | 55.00 (±7.09) | 0.58 (Medium) | | 50.00 (±9.09) | 52.00 (±5.19) | 0.48 (Medium) |
| Elaboration | | 63.70 (±5.37) | 60.75 (±5.35) | 0.68 (Medium) | | 54.35 (±5.75) | 58.85 (±8.65) | 0.52 (Medium) |

Then (Figure 1a) shows that students are accustomed to using smartphones in the learning process. The lowest percentage result in technological media used in learning is the use of the digital worksheet ecosystem (DWE) with an acquisition of 5%. While (Figure 1b) the selection of material in the development of this DWE, one of which is determined based on the answers of students regarding material that is considered difficult to understand by them, namely 62% of students answered ecosystem material in the interaction between species of living things, energy flow, ecosystem pyramids, and biogeochemical cycles.

Ecosystems are material related to interactions between living things and include material that is quite abstract and difficult to understand directly by students. In addition, the results found from the students' questionnaire answers regarding the use of learning resources, that independent learning teaching materials for students are still lacking. 74% of respondents answered that learning resources were commonly used from websites (brainly, Wikipedia, blogs and the like).

The following are the results of students' answers in the use of independent learning resources folded in (Figure 1c). The use of other learning resources with the lowest percentage was scientific articles, at 4%. The use of scientific articles as a learning resource for students needs to be facilitated with an appropriate learning model, one of which is the TASC-based learning model. Other questionnaire results regarding the types of biology questions that students usually work on for daily assessments or learning evaluations showed that 78% answered questionnaire-type questions. This indicates that students still more often work on questionnaires that lead to closed-ended questions.

The design stage produced a DWE design that contains ecosystem material including biotic and abiotic ecosystem components, food chains, ecological pyramids, and biogeochemical cycles. The media was developed using Canva application for design and Liveworksheet for digitization, equipped with interactive features in the form of videos, images, and TASC-based activities.

Based on the percentages obtained, the average score for each aspect in the media feasibility test was 84%, with the overall product feasibility score interpreted as “highly feasible” and suitable for use in biology learning. Based on the percentage of each aspect in the material feasibility test, the score obtained was 85%, with the overall product feasibility score interpreted as “highly feasible” and suitable for use without revision. The criteria for interpreting the product feasibility test scores were adapted from (Utomo et al., 2014).

Following the completion of the feasibility test by several experts, including subject matter experts and media experts, the implementation stage was carried out. The product was implemented with a biology teacher and a group of tenth-grade science students, referred to as small- or large-group testing. Group testing was conducted to obtain feedback from users representing the actual target audience. The small-group trial involved 12 students, while the large-group trial involved 35 students.

The teacher evaluation stage was conducted by two tenth-grade science biology teachers. This evaluation aimed to determine the teachers’ responses to the TASC-based Digital Worksheet Ecosystem (DWE). At this stage, the teachers were asked to use the learning media and then complete an assessment instrument via Google Forms. The teacher evaluation encompassed four aspects: content, presentation, language, and usefulness.

The percentage results for each aspect of the biology teacher trial are presented in Table 3. Based on the obtained percentages, the overall score from the biology teacher evaluation was 86%, interpreted as “highly feasible,” indicating that the product can be used without revision. Based on the obtained percentages, the average score for the small-group trial was 92%, with the overall trial score interpreted as “highly feasible,” indicating that the product can be used without revision. The criteria for interpreting the product feasibility scores were adapted from Utomo et al. (2014).

Based on Table 5, it can be observed that in the pretest, both classes had relatively close average scores, indicating that the two groups possessed comparable initial abilities. The average posttest scores, as well as the minimum and maximum values, in the experimental group were considerably higher than those in the control group. The average post-test scores, minimum and maximum scores in the experimental group were much higher than those in the control group. This shows a significant increase in the creative thinking abilities of students who participated in learning using the experimental model. The standard deviation (SD) shows how spread out the data is from the mean. A higher SD value in the experimental group indicates that creative thinking skills in this group are more varied than in the control group. The difference in creative thinking ability scores on the pretest and posttest after applying the TASC-based Digital Worksheet Ecosystem (DWE) learning model in the experimental class and the learning model using printed worksheets in the control class shows the gain score. The higher the gain score, the greater the increase in students' creative thinking ability.

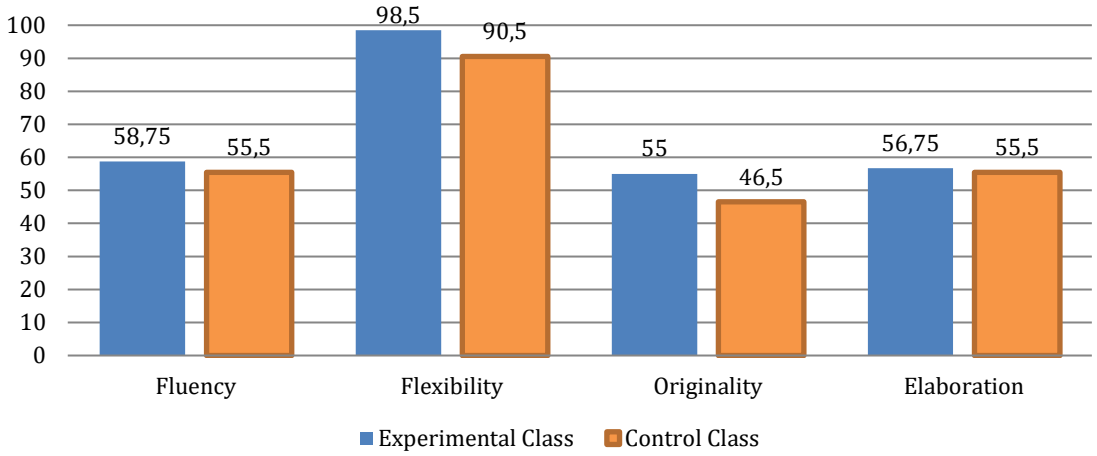


Figure 2 Comparison of improvements in creative thinking skill indicators

**Table 7 Creative thinking ability test category**

| Class | Interval value | Category | Pretest | | Posttest | | N |
|---|---|---|---|---|---|---|---|
| | | | F | % | F | % | |
| Experiment | 85-100 | Proficient | 0 | 0% | 4 | 12% | |
| | 75-84 | Proficient | 0 | 0% | 11 | 35% | 35 |
| | 65-74 | Feasible | 0 | 0% | 15 | 37% | |
| | 0-64 | Emerging | 35 | 100% | 5 | 16% | |
| Control | 85-100 | Proficient | 0 | 0% | 1 | 3% | |
| | 75-84 | Proficient | 0 | 0% | 5 | 16% | 35 |
| | 65-74 | Feasible | 0 | 0% | 20 | 48% | |
| | 0-64 | Emerging | 35 | 100% | 9 | 33% | |

The highest average indicator score in the control class pretest was observed in the Flexibility indicator. Similarly, in the control class posttest, the highest score was also recorded for the Flexibility indicator. The highest N-gain in the control class was found in the Flexibility indicator, categorized as moderate. The improvement in each indicator of the creative thinking skills test can be identified from the difference between the average posttest and pretest scores for each indicator in both the experimental and control classes. The experimental class demonstrated greater improvement than the control class across all creative thinking skill indicators. The detailed results are presented in Figure 2.

Based on Figure 2, the percentage of average posttest scores in the experimental class was higher than that of the control class. Both the experimental and control classes achieved their highest performance in the flexibility indicator, with the experimental class scoring 98.5% and the control class 90.5%. In contrast, the lowest average posttest score in the experimental class was in the originality indicator at 55.00%, while the control class scored 46.5% in the same indicator.

The categories of students' creative thinking skills refer to the proficiency levels outlined in the Learning Mastery Criteria (KKTP) of SMAS Yadika 10 Kosambi. Table 7 indicates a significant improvement in the creative thinking skills of students in the experimental class after the intervention, compared to the control class. The percentage of students classified as proficient and competent in the experimental class increased substantially following the posttest. This suggests that the intervention was effective in stimulating students' creative thinking skills. Conversely, the improvement in the control class was slower and less substantial than in the experimental class. These results conclude that the intervention applied to the experimental group had a significant positive impact on the development of students' creative thinking skills.

The thinking process facilitated through the DWE includes understanding the problems presented at the initial stage of the learning activity. This stage involves identifying and formulating problems, which is part of the early phase of the TASC model. It connects students' prior knowledge with new knowledge to comprehend the issues under analysis. The creative thinking skills empowered in this process include identifying the core problem, recognizing key terms, and determining ideas to address the problem.

This is supported by the results of expert validation on learning content, in which the sub-indicator for supporting learning materials obtained the highest mean score in the content feasibility aspect. This indicates that the DWE content has effectively facilitated students' reasoning processes

and directed them to seek further information. This aligns with the theoretical perspective that determining ideas from a problem requires creative thinking as a foundation for decision-making. Moreover, understanding content through creative thinking involves processes that cannot be separated from generating ideas, organizing, analyzing, synthesizing, evaluating, and transforming knowledge (Lunenburg, 2012).

The initial step of the TASC model implemented in the DWE aims to train students' fluency, flexibility, originality, and elaboration in order to stimulate their thinking process and deepen their understanding of specific subtopics within the ecosystem material. In accordance with existing creative thinking theories, the early stage of creative thinking involves generating ideas that can be used to solve problems or produce a work. This entails organizing information (data, questions, statements, concepts, opinions) through analysis and selection (Masitoh et al., 2019). Therefore, the learning steps in the DWE are well-organized to achieve the intended objectives.

The TASC-based Digital Worksheet Ecosystem (DWE) learning in both experimental and control classes began with a pretest on students' creative thinking skills. The calculated average scores for both classes were relatively similar. Based on Table 1, the average pretest scores in the experimental and control classes did not differ significantly. The minimal difference in pretest scores was expected, as neither class had yet received the intervention, whether in terms of the learning model or the material taught (Santoso et al., 2019). This indicates that prior to the intervention, both classes had comparable creative thinking abilities, making the sample suitable for the study (Aisyah & Sari, 2021).

Following the implementation of the TASC-based DWE in the experimental class and printed worksheets in the control class, Table 1 shows an improvement in creative thinking skills in both groups. However, the average posttest score of the experimental class was significantly higher than that of the control class. This can be attributed to the TASC-based DWE learning model, which encourages students to collaborate in groups, allowing them to explore a wider range of solutions to the problems presented. This finding is consistent with Rosidi et al. (2013), who stated that through the TASC approach, students are taught how to analyze and generate creative ideas in solving problems, enabling them to address environmental issues in their surroundings.

The difference in students' creative thinking scores between the pretest and posttest, following the implementation of the TASC-based DWE in the experimental class and printed worksheets in the control class, is reflected in the gain score. A higher gain score indicates a greater improvement in students' creative thinking skills. The improvement observed in the experimental class aligns with the findings of Rosidi et al. (2013), which demonstrated that the TASC model can effectively enhance creative thinking skills. Furthermore, the DWE fosters creativity and innovation by encouraging students to draw knowledge from multiple disciplines, enabling them to view problems from different perspectives, thereby broadening their thinking and fostering creativity in problem-solving (Suryanda et al., 2023).

The fluency indicator used in this study involved asking students to provide interpretations of an image, story, or problem related to biogeochemical cycles. The findings indicate that students utilizing the TASC-based Digital Worksheet Ecosystem (DWE) were better able to generate a wider range of ideas compared to students using printed worksheets (LKPD). This is consistent with the findings of Hand et al. (2015), who stated that fluency in thinking can be influenced by a learning environment that encourages unrestricted exploration of ideas. In the TASC-based DWE, students are granted the freedom to develop multiple ideas without the constraints of overly complex structures (Bell & Sheridan, 2020). Moreover, this approach tends to make students more reflective in generating ideas, as they are required to conduct in-depth analysis before presenting a concept. This may explain why students in the control class generated fewer ideas compared to those in the experimental class.

This is further supported by Rosidi (2017), who argued that the TASC-based DWE can enhance students' creative thinking skills. The structured stages in the TASC framework may prompt students to be more careful and reflective when formulating ideas, leading to fewer ideas in the printed LKPD group compared to the broader exploratory opportunities offered by the DWE. The fluency indicator, which measures the ability to think fluidly, revealed that generating numerous ideas spontaneously remains a common challenge for students. This aligns with findings by Kurnia et al., (2021). Potential contributing factors include extrinsic aspects such as the learning environment and time constraints, as well as instructional factors such as limited practice opportunities and an overemphasis on obtaining the correct answer (Wijaya & Dani, 2024). These results indicate that fluency requires more intensive and sustained practice and stimulation.

The next indicator, flexibility, refers to the students' ability to propose varied perspectives or categories of solutions in addressing a problem (Runco & Acar, 2012) In this study, students in the experimental class demonstrated higher flexibility scores than those in the control class. The questions required students to identify differences between biotic and abiotic components and to provide reasons why such differences could be considered creative and innovative. The TASC-based DWE encouraged students to explore diverse solutions, enabling them

to generate more unique and varied responses compared to other instructional models. This finding is supported by Rosidi et al. (2013), who found that the TASC model enhances flexibility by guiding students to explore multiple possible solutions. In contrast, printed LKPDs tend to emphasize final outcomes without sufficiently exploring alternative solutions.

Consequently, students in the experimental class were better able to produce diverse solutions compared to those in the control class. This aligns with findings reported in the *Jurnal Pendidikan Sains*, which showed that the TASC-based DWE improves students' creative thinking skills, including flexibility (Rahman & Maslianti, 2015).

The significant improvement in flexibility within the experimental group can be attributed to several factors. First, the TASC-based DWE promotes collaboration in heterogeneous groups, fostering richer and more diverse idea exchange. Second, its emphasis on authentic problem-solving encourages students to think both critically and creatively when developing solutions. Third, the approach allows students to connect concepts across various disciplines, broadening their perspectives and stimulating the emergence of new ideas. These observations are consistent with the research of (Suyitno & Habibi, 2020).

The originality indicator recorded the lowest scores in both the experimental and control classes. The low originality scores suggest that the ability to produce truly novel ideas remains a challenge for students, a finding consistent with Rosidi et al. (2013) and Lestari et al. (2019), who reported that originality often scores lower than other creative thinking indicators. Contributing factors may include both internal and external elements, such as lack of motivation, limited knowledge and experience, inadequate analytical skills, environmental influences, and insufficient critical and creative thinking practice (Lestari & Lingga, 2024). This implies that originality requires imagination, problem-solving skills, flexible thinking, openness to new experiences, and the confidence to step outside one's comfort zone.

Finally, the elaboration indicator refers to students' ability to develop and expand on an idea in detail. The results indicate that elaboration scores in the experimental class were higher than those in the control class. In this study, students were asked to explain in detail the stages of a food web. This task encouraged elaborative thinking by prompting students to articulate processes in a comprehensive and structured manner. This model guides students through systematic stages of creative thinking, such as understanding problems in depth before generating various solutions. In contrast, printed worksheets emphasize the final result without exploring various possible solutions. Therefore, students in the experimental class were better able to generate varied solutions than students in the control class. This is in line with research published in the Journal of Science Education, which shows that the TASC-based digital worksheet ecosystem (DWE) can improve students' creative thinking skills, including in the aspect of flexibility of thinking (Rahman & Maslianti, 2015).

## D. Conclusion

This study concludes that the TASC-based Digital Worksheet Ecosystem (DWE), developed through the Hannafin and Peck model, is highly feasible and effective in improving students' creative thinking skills in ecosystem learning. The needs analysis revealed students' reliance on informal digital sources and difficulties in understanding abstract ecosystem concepts, highlighting the urgency of structured, interactive digital learning media. Expert validation, teacher evaluations, and group trials consistently indicated that the product was highly feasible without revision. Experimental results demonstrated that students who learned using the TASC-based DWE achieved significantly higher improvements across all creative thinking indicators (fluency, flexibility, originality, and elaboration) compared to those using printed worksheets. These findings suggest that integrating structured creative problem-solving stages with digital interactivity can meaningfully enhance higher-order thinking skills in biology education. Scientifically, this research contributes to the growing body of evidence supporting TASC-based digital learning environments as an effective approach to fostering creativity in science learning. Future research may explore long-term implementation across different biology topics and educational levels to further examine its broader applicability and impact.

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