



Teachers' Perceptions Toward Electronic Student Worksheet Based on Waste Treatment Projects to Improve Students' Creative Thinking Skills

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Abstract: This research aims to describe the perceptions of SMA/MA science teachers regarding the use of project-based electronic worksheets (e-worksheets) regarding the use of banana peel and chicken eggshell waste to improve students' creative thinking skills. The research method used is a mixed method with Sequential Explanatory Design. Data was collected through a questionnaire and interview and then analyzed using a descriptive approach. Questionnaires were distributed to 20 science teachers, and interviews were conducted with five science teachers. The research results show that teachers positively perceive using project-based e-worksheets to utilize banana peel and chicken eggshell waste. From these results, as many as 65% of teachers have not used project-based e-worksheets. One of the environmental problems faced in Karimun Regency is the abundance of banana peel and chicken eggshell waste, which causes environmental pollution in people's homes. The currently available worksheets do not fully develop students' creative thinking skills, which are low. From the research results, it can be concluded that a project-based e-worksheet for processing banana peel and chicken eggshell waste is necessary to improve students' creative thinking skills as an alternative teaching material in the learning process.

Keywords: creative thinking skills; e-worksheet; PjBL; perception; waste

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INTRODUCTION

Globalization has ushered in a new era of human existence marked by significant shifts from the previous century's order of life to the 21st (Jayadi et al., 2020; Petkova et al., 2024). The quantity of advanced technology created to expedite and simplify all human endeavors is one of the indicators (Jamun, 2018). In addition to knowledge, the resultant advanced technology is skill-based (Mardhiyah et al., 2021). Businesses and industries in this era need information technology, media, and innovation skills (Ghufron, 2018). This is when having 21st-century skills that emphasize critical and creative thinking becomes extremely important (Munawwarah et al., 2020). Thus, it is necessary to have qualified human resources who possess the abilities outlined in the 21st-century skills framework. The 21st-century education framework outlines certain critical thinking, communication, collaboration, and creativity (or 4C) skills that today's students need to be prepared to face the challenges of this century (Muhali, 2019). In the period of a Merdeka curriculum, schools must support 4C skills because students need these abilities to succeed in the workforce. The curriculum is designed to help students develop critical thinking, teamwork, communication, and creativity skills, among other competencies (Brata et al., 2023). Creative thinking skills are one of the 21st-century skills that play an important role in making students able to compete in the world of work.

Creative thinking refers to the comprehensive range of mental processes employed by individuals in response to a particular subject, challenge, or circumstance or in an endeavor to address a specific occurrence or issue, drawing upon the abilities of those individuals (Birgili, 2015). Students with creative thinking abilities learn to be adaptable, see possibilities, deal with obstacles in an expanding world, and create original and practical solutions for living in the future (Siew & Ambo, 2018). According to Endang et al. (2022), creative thinking has the guts to try new things, experiment, and invent to come up with fresh ideas, examine challenges from many perspectives, and think beyond the box. Students' creative thinking abilities need to be improved because, in actuality, they are still comparatively low in the learning process (Kurnia, 2021). Students' capacity for creative thought falls into the last group (Tayuda & Siswanto, 2020). Creative thinking receives inadequate attention during school education (Purwati & Alberida, 2022). According to Yulianto (2021), the classroom learning process has not enhanced students' capacity for creative thought. Therefore, teachers need the ability to package a good learning process so that students gain direct learning experience.

A teacher's capacity to package well-designed learning experiences significantly impacts students' meaningful experiences (Agustin et al., 2023). The learning process will be more successful if learning

experiences demonstrate the relationship between conceptual elements (Agustin et al., 2023). In order to extend learning beyond just assigning assignments, teachers should undertake learning that develops students' skills for creative thought. Today's students need to be more adept at using knowledge to solve practical issues, adapting and innovating in the face of shifting conditions and demands, and maximizing the potential of technology to innovate new products. However, there has not been any innovation in the teaching methods employed by educators, and most of the content is still sourced from the internet. As a result, the learning programs are not grounded in real-world issues, and the learning resources do not foster students' creativity.

An essential component of problem-solving is creative thinking (Duyar et al., 2018). One way to enhance students' creative thinking abilities is to have them solve actual environmental challenges (Subarkah et al., 2017) and students creatively solve these problems (Agustin et al., 2023). Karimun Regency has real problems that can be used as a medium for learning. One of the problems is the lack of strategy in waste management (Tofani et al., 2022). This means that much waste could still be utilized and is not managed correctly. For example, waste from banana peels and chicken eggshells. One effective alternative for processing organic waste is to process it into liquid organic fertilizer because it can help fertilize plantation and agricultural land (Kusumaningtyas et al., 2022). Project Based Learning (PjBL) is one of the learning models that can address the aforementioned issues.

Learning activities through Project Based Learning (PjBL) can enhance students' learning outcomes and creative thinking skills (Fadhil et al., 2021; Rahardjanto et al., 2019). With project-based learning (PjBL), students can apply information they have previously or will soon gain to real-world tasks (Juuti et al., 2021). When project-based learning is used in the classroom, the teacher facilitates learning rather than serving as a subject matter expert. A key component of student facilitation is an ongoing conversation between the teacher and the class. Furthermore, projects are typically complicated and include complex tasks requiring student problem-solving. Teachers must thus assist students in finishing challenging assignments (Jumaat et al., 2017).

Most student projects occur outside the classroom, with students working alone to solve problems within time constraints. Student worksheets are, therefore, required as a reference to direct their projects. Thanks to technological developments, students can now access worksheets more easily by having them available electronically as an E-worksheet. A conveniently accessible educational resource over the Internet, e-worksheets are created with digital media and are symmetrical, systematic, and visually appealing to meet learning objectives (Shalahuddin & Hayuhantika, 2022). The project-based E-worksheets have been examined by several researchers, including Saifuddin and Kuntjoro (2021), who found that e-worksheets based on ecopreneurship and trash recycling were very practical in teaching students' entrepreneurial desire, both conceptually and empirically. Agustin et al. (2023) revealed that developing an e-worksheet based on chicken manure waste processing could improve students' creative thinking skills. However, no research has examined e-worksheets based on actual problems in the surrounding environment, namely the waste processing project for banana peels and eggshells. This study examines science teachers' and students' perceptions of scientific learning via an online worksheet designed to enhance students' skills for creative thought based on the waste project banana peels and chicken egg shells. These discoveries also offer insight into the intricacies of pedagogical tasks, highlighting the novel approach of combining environmental issues, such as waste treatment, with project-based learning (PjBL) to improve students' creative thinking skills. This research contributes to the scientific field by demonstrating the practical application of e-worksheets as an innovative educational tool that bridges real-world environmental challenges with developing critical 21st-century skills. It can help teachers prepare their teaching materials by providing information for their professional development.

METHODS

This study included 20 biology teachers. This study combined data collection and qualitative and quantitative data analysis in a sequential explanatory design, utilizing mixed methods research modified from (Creswell, 2012). This study was conducted in February 2024 at SMA/MA in Karimun Regency. Initially, the researchers conducted a thorough literature review, examining recent studies on e-worksheets, PjBL (Project-based Learning), and the enhancement of creative thinking skills. Subsequently, an instrument will be devised to assess the requirements of biologists' teachers regarding teaching materials. These instruments were then disseminated to 20 biology teachers in Karimun Regency via Google Forms. The questionnaire statements for teachers and students and interview guidelines focused on three key aspects: utilizing e-worksheets in science learning, implementing PjBL centered on problem-solving, and cultivating creative thinking skills. The sequential explanatory design state technique used in the research design scheme (Figure 1) is based on quantitative research first, followed by qualitative research (Shorten & Smith, 2017; Agustin et al., 2023; Rosaria et al., 2023).

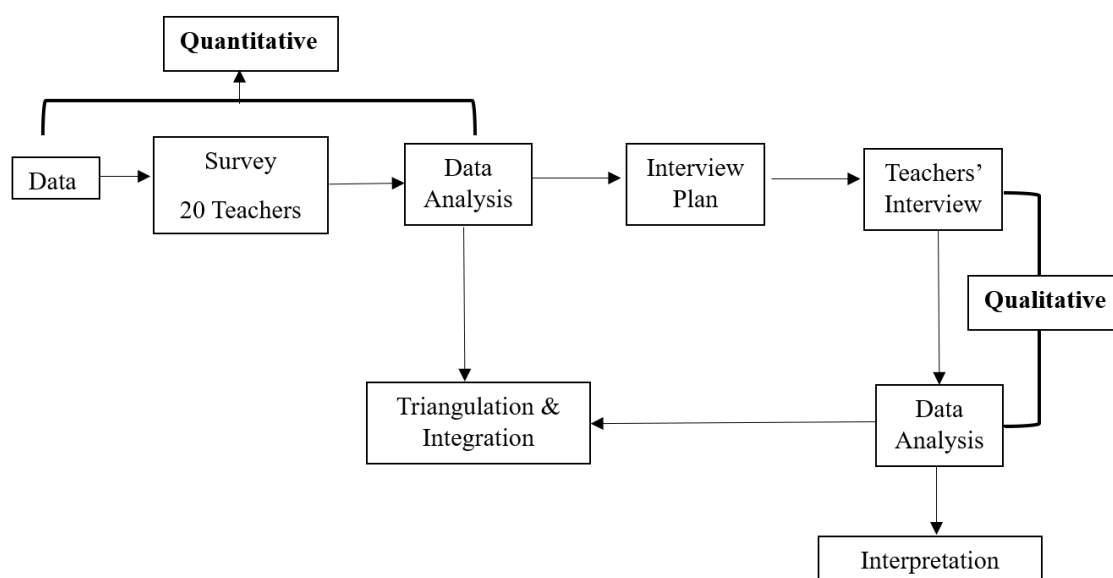


Figure 1. Schematic research design

The data analysis techniques employed in this study comprise four main techniques: data collection, data reduction, data display, and verification. The data collection phase commenced with the distribution of questionnaires to 20 teachers. Subsequently, data reduction was executed, involving identifying, clarifying, and eliminating extraneous data, focusing solely on pertinent aspects aligned with the research objectives. Following this, the data display stage ensued, wherein data was summarized and organized systematically to ensure accuracy and completeness. Finally, data presentation and conclusion drawing were conducted. In addition, interviews were done to learn why they used project-based learning models for science learning, e-worksheets, and creative thinking in the classroom. An integrated and triangulated approach was used to examine quantitative and qualitative data.

Research data from teacher surveys were analyzed by classifying responses based on questionnaire questions, assigning a score to each response per the scoring guidelines, and computing the sum of the scores for all questions answered. The questionnaire employs the Guttman scale, which offers "Yes" and "No" response options with scores of "1" and "0" under the question's contents. Next, the % score is determined, and a qualitative interpretation is provided. The following formula is used to determine the percentage score for each item (Wahyudi et al., 2014).

RESULT AND DISCUSSION

This section describes the discussion and research findings based on data collection and analysis. The collection and analysis of data obtained from research was carried out by distributing questionnaires to 20 biology teachers at SMA/MA IN Karimun Regency, which is shown in Table 1.

Table 1. Result of Interpretation of Teachers' Perception Questionnaire

Question	Percentage (%)	
	Yes	No
Do your science learning activities make use of student worksheets?	55	45
Worksheets can now be given as electronic worksheets since technology is developing quickly. Is it crucial for science learning to use electronic worksheets?	100	0
Have you ever applied the concept of science learning using a project-based learning model?	35	65
Has your science learning made use of project-based electronic worksheets?	35	65
Are science lessons about environmental pollution currently grounded in real environmental issues?	75	25
Have the topics of biotechnology and environmental pollution been taught using a project-based learning activity model?	35	65
Are you familiar with creative thinking skills?	75	25
Do you agree that a teacher's role in learning activities is to help students develop their creative thinking skills?	100	0
Have you trained students' creative thinking skills in science learning?	80	20

Are real-world environmental problem-solving exercises necessary for honing students' creative thinking skills?	100	0
Have you implemented project-based learning on waste management of banana peels and chicken eggshells to improve students' creative thinking skills?	15	85
Have you ever conducted a test to measure students' creative thinking abilities?	35	65
If yes, do the students exhibit the expected level of creative thinking skills?	35	65
Is it necessary to develop students' e-worksheets whose contents can train creative thinking skills?	100	0
To enhance students' creative thinking skills, do we require teaching materials in e-worksheets based on processing banana peels and chicken eggshells?	100	0

Table 1 shows that 55% of science teachers have used worksheets in science instruction, while 45% have not. All science teachers concur that using electronic worksheets is crucial for science instruction because, as technology develops, it is expected that students will be able to keep up with it and assess what knowledge they need. Nowadays, with the advancement of technology, most students are less interested in worksheets and more in learning resources that use computers, laptops, and even smartphones. E-worksheets can support and ease the process of teaching and learning activities, fostering productive relationships between educators and students that will train students' skills. According to (Haryanto et al., 2020), e-worksheets can support and promote instructional activities, resulting in fruitful interactions between teachers and students that can boost student engagement and improve learning outcomes.

This study introduces a novel approach by developing a project-based e-worksheet that integrates waste management into science learning, specifically utilizing banana peels and chicken eggshells. Unlike previous studies focusing on project-based learning or digital worksheets separately, this research combines real-world environmental issues with technology-enhanced learning materials to improve students' creative thinking skills. Prior studies have shown that project-based e-worksheets effectively enhance students' creative thinking and digital literacy skills (Sari et al., 2021).

Based on Table 1, it can be seen that only 35% of teacher respondents have used the project-based learning model in science learning and have utilized project-based e-worksheets obtained from the internet. 65% of teacher respondents who had not used the project-based learning model admitted that it was because they did not understand the steps of the project-based learning model, so they had difficulty applying it in the classroom learning process. Even though project-based learning is very useful for students in helping develop three domains of learning, namely, cognitive, affective, and psychomotor (Febriansyah et al., 2021), teachers still face challenges in implementation. Furthermore, this study's impact extends beyond education, as it provides a sustainable solution to organic waste management. Research has shown that banana peels and eggshells can be repurposed to produce eco-friendly paper (Yusuf et al., 2024) and biodegradable plastic (S.Divya & Daniel, 2021). By integrating these findings into classroom learning, students are trained to think creatively and encouraged to develop environmentally friendly innovations. Therefore, this study bridges the gap between theoretical knowledge and practical environmental problem-solving, offering a dual impact on education and sustainability. According to Colley (in Diawati et al., 2020), there are six learning stages in project-based learning: orientation, identification, determination, planning, implementation, documentation, reporting, evaluation, and implementation of projects. The teacher assigns tasks to the students, such as producing tapai and tempeh and separating organic and inorganic waste bins.

Additionally, the teacher's use of PjBL is not predicated on current issues. However, the Karimun Regency's main issue is the abundance of rubbish, which includes waste from chicken eggshells and banana peels. The teacher never assists students in finishing it. This demonstrates that the teacher's understanding of the PjBL steps is incorrect. The teacher interviews clarify the data on project-based learning steps. The majority of teacher respondents, up to 75%, already know about creative thinking skills. However, there is a difference between the creative thinking skill indicators that should be measured and the indications of creative thinking skills teachers comprehend. Just 35% of teachers have given tests to measure their students' creative thinking skills. They said that the ability to solve issues, generate ideas, engage in debate, and provide specifics was a sign of creative thinking in students. Teachers' understanding of students' creative thinking abilities is not yet following the indicators they should be. Three components comprise the capacity for creative thought (Torrance, 1965): (1) fluency (originality), (2) elaboration, and (3) originality, whereas thinking in detail (elaboration), thinking flexibly, thinking creatively, and thinking to assess (evaluation) are characteristics of creative thinking skills related to cognition (Munandar, 2009). All teachers (100%) who responded to the survey expressed satisfaction with creating e-worksheets based on projects involving processing banana peels and chicken eggshells to improve students' creative thinking skills. The ability of students to think creatively will determine their success in the future because these skills are essential to everyday living (Pramesti et al., 2022). The information below comes from interviews conducted with 5 science teachers to learn more about their reasons

for utilizing worksheets, project-based learning (PjBL), and creative thinking skills in the classroom. Data collected through questionnaires shows that 55% of teacher respondents have used student e-worksheets in science learning, and all teacher respondents stated that in 21st-century learning, there is a greater need for electronic student worksheets in science learning. In this interview, we will explore further how students use teacher worksheets.

According to the resource person, Teacher 1 stated: *"When studying science, I never use worksheets, whether sold on the market or worksheets that I make myself because I do not have time to make them. So, in my learning, I more often use lecture, discussion, and question-and-answer methods in the learning process in class because I think these methods are easier to apply to students. To give assignments and practice, I give practice questions to students from the questions in the printed book"*.

Teacher 2 stated: *"I never use worksheets during the science learning process. I only give them practice questions I have created myself with a combination of practice questions in printed books for them to discuss. I do not have time to make my worksheets, and buying worksheets from publishers is quite expensive, so we do not want to pass that on to students."*

Teacher 3 stated: *"I have used student worksheets in the science learning process; I usually take them from the internet by modifying them to suit the remaining conditions at the school where I teach."*

Teacher 4 stated: *"I have never used worksheets in science learning. This is because the facilities and infrastructure for making worksheets themselves are inadequate. I prefer to use work activities or practice questions in printed books rather than making worksheets because I do not have the time to make them; buying worksheets sold from publishers is expensive"*.

Teacher 5 stated: *"When learning science in class, I never use worksheets. I only used the practice questions in the book"*.

According to the questionnaire and interview results, five teachers' respondents stated that e-worksheets are an excellent way for students to develop their creative thinking abilities since they save time and offer conveniently available, motivating, and engaging learning resources. Based on the responses provided during interviews, it is evident that a few of the respondents primarily utilize e-worksheets that they get from the internet; they have not utilized e-worksheets that are based on actual problem-solving projects in the real world. In learning e-worksheets, students will complete several exercises to solve problems and draw conclusions. They will also be trained to discover concepts independently during group discussions (Nyeneng et al., 2021).

In 21st-century learning, it is hoped that the use of student worksheets will shift to the use of electronic worksheets. Electronic worksheets can integrate learning videos by including a digital link to the video and a summary of the material, problems, questions, and instructions for carrying out assignments taken by students during the learning process. The work is carried out by students in groups and individually (home assignments), which are related to videos containing natural phenomena in everyday life so that the learning material is easy to understand (Fitri & Desnita, 2023).

Based on the teacher response data, it was found that 35% of teachers already knew about project-based learning. However, not all teachers know the syntax or steps to consider when using the project-based learning model. This interview will further explore teachers' perceptions of project-based learning.

According to the resource person, Teacher 1 stated: *"Based on my knowledge, project-based learning is a learning model where the teacher gives projects to students for them to complete in groups. However, I do not remember the steps of the learning model. I never use project-based learning because, in my opinion, students will take a long time to prepare a given project, so the time given will not be enough. I have also never produced a product in science learning, whether in processing waste or utilizing waste from banana peels and chicken eggshells"*.

Teacher 2 stated: *"In my opinion, the project-based learning model is a student-centered learning model where students complete a product given by the teacher. The steps for project-based learning are 1) establishing a project theme, 2) establishing a learning context, 3) planning activities, 4) processing activities, and 5) carrying out activities to complete the project. I have never implemented this learning model because the school facilities and infrastructure are inadequate. However, I have already produced products in science learning, namely in biotechnology material where students were asked to make tempeh"*.

Teacher 3 stated: *"In my opinion, the steps for project-based learning include determining a topic, designing a product plan, preparing a production schedule, monitoring project progress, testing results, and evaluating. In my opinion, project-based learning is important to apply to science learning because it can encourage cooperation between students in completing assignments so that students'*

communication and collaboration skills can be trained. I have used a project-based learning model in science learning. The project I have done is making compost. I asked students to collect rubbish from fallen leaves around the school environment".

Teacher 4 stated: *"The goal of the project-based learning model is to solve challenges set by the teacher by having students produce product. The orientation phase, project identification and determination, project planning, project implementation, project documentation and reporting, and project evaluation and implementation comprise the syntax of project-based learning. I have never used a project-based learning approach since it is time-consuming and requires inadequate resources. However, I have used project-based learning that generated a finished good is making tapai from cassava".*

Teacher 5 stated: *"The processes for project-based learning, in my opinion, are making an assignment plan, scheduling time with students, assessing the work by having them show their work, and making comments or suggestions. In my opinion, applying project-based learning to science education is crucial as it teaches students time management skills. Students in project-based learning have a set amount of time to do their assignments. "In studying science, the project I carried out was making salted eggs from duck eggs."*

Based on research and interview results, the syntax of the project-based learning model that teachers understand differs from what it should be. According to [Suradika et al. \(2023\)](#), there are 6 steps to the project-based learning model, including starting with important questions, designing the project, making a schedule, monitoring students and project progress, assessing project results, and evaluating experience. Although some educators have used project-based learning processes in science learning, they have not applied them fully to students' real-life environmental problems. Real-world actions that directly relate to the environment are the actions used to create a project ([Ardianti & Raida, 2022](#)).

The interview results also found that most teachers have not used the project-based learning model because it would take a long time. This follows [Yusriani et al. \(2020\)](#), who state that the PjBL model's challenges include time allocation outside class and limited equipment or infrastructure. This is a challenge teachers should face because project-based learning has been proven successful in improving students' 21st-century skills. Project-based Learning (PjBL) is a cutting-edge model of learning that has proven successful in the 21st century ([Bell, 2010](#); [Safaruddin et al., 2020](#)).

Based on questionnaires, 75% of teacher respondents know about creative thinking skills, and all teachers agree with the importance of teachers' role in improving students' creative thinking skills. However, teacher respondents do not yet understand what indicators should be used to measure students' creative thinking skills. This interview will further explore teachers' perceptions of creative thinking skills.

According to the resource person, Teacher 1 stated: *"Although the term "creative thinking skills" is still new to me, I am familiar with the term creative. However, I do not understand what indicators state about these skills. I never use learning models or other tools to improve students' creative thinking skills. Utilizing waste from banana peels and chicken eggshells can train students' creative thinking skills because students are asked in groups to create projects".*

Teacher 2 stated: *"I have heard the term "creative thinking skills," but I do not know the indicators. I teach in class as usual, using the lecture method, conducting discussions, and asking students questions. I do not know whether I have practiced these skills in the learning I have done or not. The project of utilizing banana peel and chicken eggshell waste can train students' creative thinking skills".*

Teacher 3 stated: *"I know about creative thinking skills, but I do not know the indicators. I have never made project-based worksheets to improve students' creative thinking skills because, so far, I have only taken worksheets from the internet and adapted them to the conditions of the students at my school. So, I do not know yet whether my work has improved students' creative thinking skills. I think this project of using waste from banana peels and chicken eggshells to make liquid organic fertilizer can train students' creative thinking skills."*

Teacher 4 stated: *"I do not know about students' creative thinking skills and how to improve them in the learning process because I never use them when teaching students. Students' creative thinking skills can be improved by working on a project utilizing banana peel and chicken eggshell waste because this project is related to students' real environment".*

Teacher 5 stated: *"Creative thinking skills are something new for me because so far, I have only adapted science lessons to what is in printed books. However, I believe this project of utilizing waste from banana peels and chicken eggshells can train students' creative thinking skills because students must complete their projects according to the time set by the teacher".*

Learning science requires creative thinking skills (Fatmawati, 2016). Based on the results of questionnaires and interviews, 75% of teacher respondents knew about students' creative thinking skills, and all agreed that teachers play a role in improving students' thinking skills. However, only 35% of teachers have measured students' creative thinking skills. The measurement of creative thinking skills has also not been carried out according to the indicators because not all teachers understand this. From the interviews, it was found that teachers had not yet developed students' creative thinking skills using banana peel and chicken eggshell waste. However, all teachers agreed that developing an e-worksheet on using banana peel and chicken eggshell waste was necessary to improve students' creative thinking skills. Project-based learning is a learning model that can enhance creative thinking skills (Sumarni, 2015; Wijayati et al., 2019).

CONCLUSION

Based on the findings and discussion, science teachers have not optimally utilized electronic student worksheets, project-based learning, and creative thinking skills in the classroom. Around 65% have not implemented project-based e-worksheets or integrated banana peel and eggshell waste into lessons, contributing to environmental pollution. Despite 75% possessing creative thinking skills, their understanding of key indicators is limited. The findings highlight the need for innovative teaching materials to enhance creativity, with e-worksheets based on waste processing showing potential as effective tools. This approach fosters problem-solving, critical thinking, and environmental awareness while increasing student engagement. Future research should explore broader implementation and long-term impact.

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