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# Lesson Plan Design Process Develops STEM Design Thinking Through Science Grade 4


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**ABSTRACT:** Within the context of fundamental STEM education, the primary objective of this article is to investigate the process of developing lesson plans specifically for the aim of fostering students' capacity for design thinking in the field of science. When it comes to the process of document gathering and analysis, the qualitative research approach is utilized. The outcomes of the study indicate that design thinking makes a substantial contribution to the development of students' creative activities and their ability to engage in problem-solving activities. In addition, it has been demonstrated that design thinking is an extremely efficient method for supporting students in their educational pursuits. Education in the fields of mathematics, science, technology, and engineering are all equally important. while it comes to the field of STEM education, it is essential to adhere to a particular method while developing lesson plans to encourage the growth of design thinking in students. In order to improve the efficiency of STEM education and to provide recommendations regarding areas that need additional research on the subject matter, the purpose of this article is to supply academics and teachers with resources that are pertinent to the subject matter.



**KEYWORDS:** design thinking, STEM, student, Science, lesson plan


## I. INTRODUCTION

Design thinking in education is defined as the analytical and creative process of exploring opportunities, testing, prototyping, gathering feedback, and redesigning (Razzouk & Shute, 2012). This method is becoming increasingly popular and relevant in the field of education as it focuses on problem solving, thereby enhancing students' deep understanding of needs, challenges, and problems (Goldman & Kabayadondo, 2016). Design thinking shifts the focus from individual work to team collaboration, through activities such as interviewing, finding needs, aggregating data, and prototyping (Kijima et al., 2021). This enhances students' creative problem-solving abilities (Gözen, 2016). In general education, research has shown that students can learn through the design process and develop design thinking through STEM education (Li et al., 2019). However, design thinking has not been emphasized in traditional general education, as it is often considered to belong to professional mathematicians and scientists, rather than students (Li et al., 2019). However, with the support of teachers, design thinking can be an appropriate method to foster a positive STEM-integrated learning experience for students (Chiu et al., 2021). Previous studies have shown that STEAM learning begins with identifying real-world problems (Boakes, 2020). Then, to solve that problem, students focus on problem-solving skills (Herro et al., 2017) and collaborative teamwork (Jolly, 2014). Research by Slater et al. (2020) demonstrated that a STEM learning model based on design thinking has a positive effect on student learning outcomes and academic motivation (Slater et al., 2020). Similarly, research by Roddy & Polfuss (2020) has also shown that design thinking models are effective in improving students' creativity and learning outcomes (Roddy & Polfuss, 2020). Engaged in design thinking, students can develop their capacity to think creatively and work collaboratively (Yalçın & Erden, 2021). Design thinking encourages diverse perspectives in considering and solving problems, which is important for creativity and innovation (Chiu et al., 2021). Therefore, in the current movement to develop and implement integrated STEM education, design thinking is becoming increasingly important (Li et al., 2019; Schweingruber et al., 2014). Researchers have demonstrated that using design thinking as the primary pedagogy benefits students when learning about STEM (Li et al., 2019). For example, the practice of design thinking has significantly improved academic performance in Physics for both male and female students (Simeon et al., 2020). Current research has demonstrated that design thinking is a rich and productive field for academic discussion and research (Kavousi et al., 2020; Strimel et al., 2020; Wind et al., 2019). English's (2019) study of 4th graders solving a shoe design problem demonstrated that students are more aware of the STEM knowledge to use and have the ability to apply that knowledge to make decisions and explain (English, 2019). Studies of student design thinking and its development, especially in and through STEM education, provide an important foundation for the development of sound curricula and instructional methods. Stemming from this issue, the

paper aims to answer that research question: How to design a lesson plan that develops students' design thinking through STEM Science lessons?

## II. METHODOLOGY

The paper uses qualitative research methods to study relevant scientific literature, search for literature and synthesize materials, analyze theoretical bases related to design thinking and the lesson design process develops design thinking of primary school students through STEM Science lessons.

## III. RESULTS AND DISCUSSION

### *A. The lesson plan design process develops design thinking STEM through Science grade 4.*

Step 1: Select lessons in the Science curriculum to determine the lesson content that will be designed towards developing STEM design thinking. When choosing lessons for design, attention should be paid to the following issues:

(1) What is the objective of the lesson?

(2) What is STEM-integrated content?

(3) What are the opportunities to use your knowledge in practice?

(4) Is it appropriate for the student's ability?

Step 2: Determine the objectives of the lesson and STEM knowledge and skills integrated into the lesson.

Step 3: Prepare teaching aids and materials.

Step 4: Design teaching activities to develop design thinking through STEM lessons. Teaching activities both ensure the technical design process of STEM lessons and ensure the stages of the STEM design thinking process.

* Warm-up activity.

* Explore.

* Practical and application activities: The process of this activity includes the following steps:

i) Connect - propose ideas:

+ Build empathy (Empathizing with program participants, knowing their preferences and needs is crucial in identifying problem situations that are right for them: Using pastels, pencils, crayons, young people have developed a way of visually expressing user needs);

+ Identify search needs (identify identified issues in accordance with the interests and needs of learners).

ii) Design and implementation of ideas:

+ Brainstorming (developing innovative solutions that have never been tried before);

+ Prototyping (create an example of a solution by identifying the best of the solution proposals to solve the problem: using basic prototyping materials such as recycled plastic bottles and cardboard, glue, tape, scissors and molding powder, teams developed tangible products that can be tested);

+ Test (solution proposals found at this stage are all checked. Depending on whether the problem is solved, it is possible to reconsider the definition of the problem, design phases and prototypes).

iii) Reporting and sharing of results.

+ Learners report learning products.

iv) Evaluation

+ Learners participate in self-assessment and peer assessment based on a given number of criteria or agree to build previous assessment tools.

Step 5: Design tools and evaluation criteria for each activity

+ Select the type of assessment tool suitable for the lesson of developing design thinking through STEM lessons.

+ Design evaluation criteria for each assessment tool.

### *B. Illustrative example.*

Step 1: Select the content "Yeast used in food processing" in the 4th grade Science curriculum to design lessons to develop STEM design thinking.

Step 2: Determine the objectives of the lesson and STEM knowledge and skills integrated into the lesson as follows:

After completing the lesson, students can:

- Discover the benefits of some yeast in food processing through hands-on experiments or observing pictures and videos.
- Have the opportunity to develop communication and cooperation capacity through teamwork.
- Have the opportunity to develop hardworking, honest qualities through the completion of assigned academic tasks.

Other STEM knowledge and skills mobilized in the lesson:

- Technique (T): Prepare some foods using yeast.
- Technology (E): The process of using yeast in the processing of some foods.
- Math (M): Measure the volume and capacity of raw materials used for food processing.

Step 3: Prepare teaching supplies.

- For teachers:

Pictures or videos related to the use of yeast in food preparation.

References to yeast types and how to use them in food.

- For students: Notebooks, pens; Picture or video to observe; Some types of yeast, materials necessary for practical activities and application.

Step 4: Design teaching activities to develop design thinking:

* Warm-up

- The teacher asks the question: Why do you think the bread we eat every day is porous?
- Students think individually, answer questions
- Other students collate comments.
- The teacher leads into the lesson.

* Explore (background knowledge discovery)

Learn the benefits of yeast in food processing.

- Teachers ask students to read information in study sheets, observe diagrams, and have double-group discussions.

Read the following information and answer the question: Yeast is used in brewing, wine and yeast used in food processing. Wine yeast can convert sugar into alcohol. Inside wine yeast contains a lot of beneficial microorganisms that support the breakdown of starch to create sugar and then convert it into rice wine. When making cakes, put cake yeast into the dough to create air bubbles, help the dough expand and make the cake puffy and spongy. There are two basic types of yeast in baking: dry yeast and fresh yeast. Fresh yeast is also known as cake yeast or yeast shaped like a solid mass. Each fresh yeast cube contains about 70% moisture and is often used by baking professionals. Outwardly, fresh enamel is brown, moist, soft, and fragile into small masses. Specifically, fresh yeast is most appreciated when it helps the cake rise quickly, activate faster, and work for a longer time. Therefore, this yeast can be used for some cakes that have a long baking time. However, fresh yeast has a short shelf life, usually only about 2 weeks in cold conditions; Dry yeast is the most commonly used type, whether in factories or in the home. It has the form of oblong mushroom particles. Yeast cells will be enclosed inside a rather thick mantle made up of dry dead cells with some growing media. Dry yeast has a longer storage time than fresh yeast. Dry yeast can be stored at room temperature, preferably refrigerated.

Question:

1) Why do you need yeast when making bread?
2) What kind of yeast should be used for loosening cakes?
3) What are the benefits of wine yeast?

- Students have group discussions and answer questions.
- Students report the results of discussions.
- Reviews, comments.

* Practical activities, application

i) Connect - propose ideas:

+ Build empathy: Teachers can raise problematic situations in accordance with students' abilities to connect lesson content with real life.

+ Identify search needs: Search for information related to the benefits of yeast in food processing; use of yeast in the preparation of some foods.

+ Brainstorming: Teachers suggest students to come up with ideas by asking the question "What foods can yeast be used to process?"; What kind of yeast to use? What is the process of implementing that product?

In this step, teachers can ask students to write and draw on paper ideas such as: the type of food to be processed, the recipe, the ingredients to use.

Students can share these ideas with other groups in the class to receive comments and suggestions to best realize the idea.

Students and teachers work together to develop STEM performance rubrics.

ii) Design and implementation of ideas:

+ Create products: students work in groups, implement ideas, create products as proposed ideas (making bread, making glutinous rice and wine.).

+ Check: check the designed/manufactured product (consider quality, dosage of preparation, time needed, color, taste).

iii) Reporting and sharing of results.

+ Display products at learning corners.

+ Learner’s report and present learning products.

iv) Evaluation

+ Students evaluate the process of STEM learning activities, evaluate STEM activity products based on developed

assessment tools and criteria.

+ Using criteria descriptions to assess STEM design thinking:

| Evaluation criteria | Well done | Complete | Not complete |
|---|---|---|---|
| Build empathy | Students discover for themselves the problem in practice: what yeast to use to prepare food in practice. | Students detect problems based on the suggestions and guidance of teachers. | Students have difficulty detecting problems. |
| Determine search needs | Search for information related to the benefits of yeast in food processing; Using yeast in preparing some foods from different sources such as: Internet lookup, reading newspapers, watching TV, etc. | Search for information related to the benefits of yeast in food processing; Use yeast in the preparation of some foods from a single source. | Look only for information regarding the benefits of yeast in food preparation; Use yeast in the preparation of some foods based on the material provided by the teacher. |
| Ideas | Propose ideas related to the use of yeast in food processing. | Propose ideas related to the use of yeast in food processing based on the teacher's suggestion. | Students had difficulty identifying ideas regarding the use of yeast in food preparation despite the teacher's suggestion. |
| Create a product | Carry out food processing using yeast according to the proposed process and idea. | Carry out food processing using yeast according to the proposed process and idea, but still need help from teachers. | Carry out food processing using yeast according to the proposed process and idea, but the product has not been completed. |
| Test | Check the quality of products, products to ensure quality requirements. | Check product quality, review and adjust inappropriate details. | Check product quality but do not adjust product limitations. |

## IV. CONCLUSIONS

The objective of this study is to analyze design thinking as well as the design process that is utilized to develop STEM design thinking in kids who are in the fourth grade and are enrolled in the Science subject. Students in the twenty-first century are expected to possess a variety of cognitive talents, including critical thinking, which can be demonstrated through the process of reading and assessing papers. Students are able to enhance their creative abilities and find solutions to challenges that are relevant to the actual world via the use of design thinking. Learners have multiple opportunities to strengthen their design thinking skills through participation in STEM activities, which include science as one of the subject areas that are addressed in STEM education. Incorporating design thinking into the STEM lesson engineering process is something that should be done. The findings of the research not only give academics and teachers with more reference resources, but they also create opportunities for them to implement innovations that are specific to each nation. In addition, it is a recommendation for more research on education in the STEM fields.

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