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The Effect of STEM-ThingLink Learning Design on Students' Conceptual Understanding of Nutrition

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ABSTRACT

This study aims to determine the effect of the Science, Technology, Engineering, and Mathematics (STEM)-ThingLink learning design on students' conceptual understanding. Thinglink.com is used as a platform to present problems and set STEM projects, on the topic of nutrition. This research is a quasiexperimental research with One-Shot Case Pretest-Posttest Design. Data was collected by means of pre-test and post-test to assess the improvement of students' conceptual understanding. The hypothesis test used is the paired sample t test. The results showed that there was an increase in students' understanding of the material concepts, which was marked by an increase in the pre-test score ($M=54.26$, $SD=14.73$) to post-test scores ($M=72.93$, $SD=12.63$). Paired sample t-test also showed significant results, $sig. < (0.03 < 0.05)$ which means H_0 is rejected. It can be concluded that the STEM-ThingLink learning design has a positive effect on students' understanding of nutrition concepts

Pengaruh Desain Pembelajaran STEM-ThingLink Terhadap Pemahaman Konseptual Siswa tentang Gizi

ABSTRAK: Penelitian ini bertujuan untuk mengetahui pengaruh desain pembelajaran Science, Technology, Engineering, and Mathematics (STEM)-ThingLink terhadap pemahaman konsep siswa. Model STEM-ThingLink menerapkan Engineering Design Process (EDP) dalam sintaksnya. Thinglink.com digunakan sebagai platform untuk menyajikan masalah dan menetapkan proyek STEM. Aplikasi difokuskan pada topik gizi yang diajarkan kepada siswa kelas delapan IPA di sekolah menengah pertama. Penelitian ini merupakan penelitian eksperimen semu dengan desain One-Shot Case Pretest-Posttest Design. Model pembelajaran STEM-ThingLink diterapkan pada kelas eksperimen. Pengumpulan data dilakukan dengan pre-test dan post-test untuk menilai peningkatan pemahaman konsep siswa. Uji hipotesis yang digunakan adalah uji t sampel berpasangan. Hasil penelitian menunjukkan adanya peningkatan pemahaman konsep materi siswa yang ditandai dengan peningkatan nilai pre-test ($M=54.26$, $SD=14.73$) menjadi nilai post-test ($M=72.93$, $SD=12.63$). Uji-t sampel berpasangan juga menunjukkan hasil yang signifikan, $sig. < (0,03 < 0,05)$ yang berarti H_0 ditolak. Dapat disimpulkan bahwa desain pembelajaran STEM-ThingLink berpengaruh positif terhadap pemahaman konsep gizi siswa.

INTRODUCTION

Based on the 2013 Curriculum, natural sciences in Indonesia must be implemented using an integrated science approach. Integrated science learning has challenges and levels of difficulty. In integrated science learning, students do not study each field of science separately but integrally, namely the relationship between concepts in different areas of science in the science family (Pursitasari, Nuryanti, & Rede, 2015; Puspita, 2019). Contextual learning is a system that stimulates the brain to construct patterns that embody meaning by linking academic content to the context of students' daily lives. Furthermore, contextual learning also allows students to apply and experience what is being taught by referring to real-world problems to make learning more meaningful and fun (Sari, Puspita, & Handoko, 2021). Some examples of contextual learning facilitated with joy and significant media can improve students' cognitive abilities (Sari dkk., 2021; Sasmita, Widodo, & Indana, 2021). The Integrated science learning model is contextual learning that combines several aspects or topics and connects them with everyday life, is personal and direct, presents one of the main ideas, and makes problem-solving. The stages in the integrated model, namely: the information gathering stage, the information processing stage (comparative analysis and synthesis, the preparation of reports in the form of verbal, graphic, audio, or model), and the culmination stage (presentation of reports in the form of processes and products) (Nurjannah, Wicaksono, & Budiarso, 2018). Integrative learning combines the cognitive, skills, and attitudes aspects in which the learning is oriented toward applicative abilities, creative thinking, and science concepts mastery (Safaruddin, Degeng, Setyosari, & Murtadho, 2020).

The principle of integration in science learning is not just integrating the material; the most important thing is integrating the concepts students must learn in a contextual case. To understand contextual cases,

students need an understanding of interdisciplinary concepts. Understanding the concept means that students can build meaning or messages from teaching and learning activities being taught, able to connect new knowledge and old knowledge into conceptual knowledge. Understanding the concept, which can be in the form of a schema, theory, or model, represents students' knowledge of how a learning material is structured and structured, then informed so that it can function together (Konicek-Moran & Keeley, 2015). Concept understanding is the ability of students to understand a concept's relationship with other concepts so that it can be used to solve a problem (Komarudin Komarudin, Puspita, Suherman, & Fauziyyah, 2020). Students who understand the concept can relate concepts flexibly, precisely, and efficiently to a problem.

According to Bloom's revised Taxonomy, there are seven cognitive processes in understanding a concept: remembering, understanding, applying, analyzing, evaluating, and creating (Anderson, DR, & Cruikshank, 2001). The six cognitive levels need to be applied in four dimensions: factual, conceptual, procedural, and metacognitive (Leslie, 2016).

Unfortunately, implementing integrated science learning in Indonesia is not optimal or sufficient. (Lukum, 2015) researched evaluating the implementation of science learning and stated several problems, one of which was that student learning outcomes did not meet the Minimum Completeness Criteria (KKM), and then gave suggestions for making effective learning strategies. (Febriyanti, Sjaifuddin, & Biru, 2022) also researched the implementation of Integrated science and stated that the learning method that is often used is still the lecture method.

Less than optimal Integrated science learning can be anticipated using a learning model that integrates various scientific disciplines, namely STEM. STEM has also proven to be very good in improving

understanding of the concept of material, analyzing problems, and practicing higher-order thinking skills (Allanta & Puspita, 2021; Fan & Yu, 2017; K Komarudin, Suherman, & ..., 2021; Suherman, Vidákovich, & Komarudin, 2020). An approach that combines the four aspects of STEM is a harmonious combination between real-world problems and science learning (Buckner & Boyd, 2015). The STEM approach helps students to explore science concepts so that it is useful to galvanize and support thinking capabilities and understand science concepts more thoroughly because students study design engineering and will continue to evaluate or test ideas (Sutaphan & Yuenyong, 2019).

Problems used in STEM learning provide opportunities for students to foster collaboration, critical thinking, creative thinking, accountability, perseverance, and leadership that are useful in the 21st Century. There are five characteristics of STEM. First, STEM leads to existing problems in the real world and is easily found in the environment (Ejiwale, 2012). The second characteristic is that STEM is guided by the engineering design process (EDP). The third characteristic of STEM is that STEM teaches students to investigate and explore something. The fourth characteristic of STEM involves students actively in production work, and the fifth characteristic is STEM applies the concepts of science and mathematics combined with technology and engineering. STEM research has been shown to have a positive impact on creative thinking skills (Siew, Amir, & Chong, 2015), critical thinking (Ardianti, 2020; Linh, Duc, & Yuenyong, 2019; Priatna, 2020; Sayekti, 2020; Uzuntiryaki-Kondakci & Capa-Aydin, 2013), and understanding concepts (Cotabish, Dailey, Robinson, & Hughes, 2013; Ozkan & Umdu Topsakal, 2021).

The STEM learning model trains students to understand knowledge and learning experiences in a more integrated and holistic manner and encourages

students to understand new concepts (Cheng & So, 2020; Komarudin Komarudin, Suherman, & Anggraini, 2021; Suherman et al., 2018; Vidákovich, 2021). By applying the STEM approach, students will independently learn or practice solving problems with a problem solution design which is a pre-production representation of some aspects of the concept or final design. Also, in designing problem-solving, students can apply the engineering design process (EDP) in STEM, which is a systematic, orderly, and open approach to approaching problems and finding the right solution to solve the problem (Jolly, 2016).

The engineering design process or EDP is deciding something that is done often. The basic concepts of science, mathematics, and engineering are applied to form an optimal solution to meet the set goals. Fundamental elements of the design process are the development of objectives and criteria, synthesis, analysis, construction, testing, and evaluation. EDP is one method to teach the benefits of engineering design thinking. Design thinking is identified by a set of skills that include tolerance of ambiguity, viewing from a systems perspective, dealing with uncertainty, and using speculation, replication, and experimentation to arrive at an effective conclusion. EDP is a great method that students can use in their assignments to improve their problem-solving skills (Mangold & Robinson, 2013). Several other researchers have researched the application of EDP in the learning process. Arivina & Jailani (2020) and Berland, Steingut, & Ko (2014) stated that EDP could develop students' problem-solving abilities. Another study (Ulum, Putra, & Nuraini, 2021) proves that EDP can empower students' skills in identifying problems and finding the right solutions. Syukri, Halim, Mohtar, & Soewarno (2018) also prove that EDP can improve students' problem-solving ability through research.

In this study, to provide contextual case imagination in STEM projects, researchers made STEM learning designs

using the ThingLink platform (<https://www.thinglink.com/scene/1507673051557265409>). Assignments to students about ready-to-eat food designs that utilize and generate problems, concept information, and assignments were delivered with interesting presentations using the features on the ThingLink. ThingLink is a service launched in 2010 in Finland and was first introduced to Russian users in 2015. This cloud-based service is in the same category as Glogster and Prezi, offering an alternative to traditional task and presentation formats. ThingLink is a web service that allows users to create image channels where they can tell stories using images, videos, music, and text. ThingLink recognizes objects and associates them with any information on the internet. ThingLink product creators can upload or import static images and add them to create interactive learning modules, which audiences can navigate. ThingLink works like youtube, which can share videos and images, which makes it possible to make things more interactive like animated PowerPoint presentations (Georgieva, Koleva, & Hristova, 2021; Inozemtseva, Kirsanova, Troufanova, & Semenova, 2018; Jeffery, Rogers, Jeffery, & Hobson, 2021; Lavanya, 2020).

ThingLink is often used as a learning medium because it has many advantages: increasing student interest (Jeffery dkk., 2021), improving students' metacognitive abilities, training creative, collaborative, and communicative thinking (Qadir, Yau, Imran, & Al-Fuqaha, 2020; Warrick & Woodward, 2021), and involving many students in making presentations (Celik, 2020).

The research aimed to test the effect of the STEM-ThingLink learning design on students' understanding of concepts in science learning. The material raised in the STEM learning design in this study is the human digestive system, a nutrition sub-chapter found in the eighth grade of junior high school. According to research conducted by (Nurjhani, Rustaman, &

Redjeki, 2012), the understanding of the concept of nutrition by students is quite good. Still, the teacher does not teach some concepts, especially about packaged food. Meanwhile, knowledge about the content of packaged food needs to be taught to better understand nutrition.

METHOD

The approach used in this study is a quantitative approach with a pre-experimental one-group pretest-posttest research design. One-group pretest-posttest research design is a research design that performs a test on a group before and after being given treatment. The treatment given is the application of STEM-ThingLink learning which adopts the Engineering Design Process (EDP) learning step (White, 2016). It has an empathize syntax (develops an understanding of the task or problem), define (shares a brief description of the problem with students), ideate (brainstorm solution), prototype (making a product), and test (testing the product), with STEM project assignments, where students are asked to design a ready-to-eat meal. In the define stage, students are given and explained project assignments. In the define stage, students are given information about nutrition, Nutritional Adequacy Rate (RDA), food processing and packaging, and a brief description of the problem. After that, the students were divided into four groups. The next stage, namely, identifies what is needed. The activity is in the form of students being asked to discuss problems with group friends and then look for other material sources by reading books and surfing the internet to help students solve these problems. In the next stage, namely ideate (brainstorm solution), the researcher asked students to discuss in groups the project design. The next step is a prototype (make). Students make designs that are done at home through the ThingLink platform and Google Forms. In the next stage, students present the design results in

front of the class the next day, and in the last stage, the test.

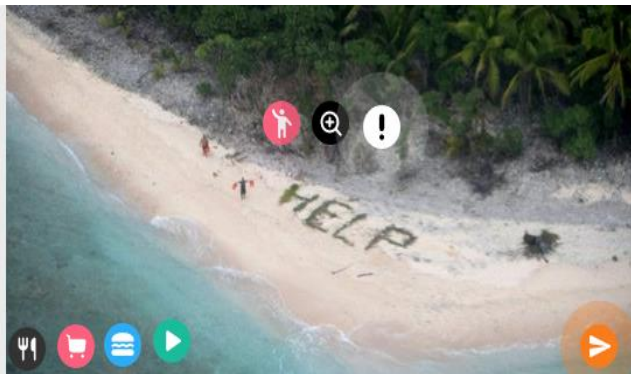


Figure 1. The Front Page of ThingLink Project STEM

Figure 1 shows the front page of the STEM project contained in the ThingLink application. On the front page, there are several icons that, when clicked, will display the information needed to work on a STEM project, such as researcher identity information, case information, information about nutrition and food processing, information about paragliding, and a google form where students work on projects. The details of the STEM project are described in Table 1.

Table 1. The STEM Learning Design

Item	Information
Generate Problem	On September 10, 2021, five young researchers went to an empty island to conduct week-long exploratory research. The five researchers set off on a small ferry. But unlucky, suddenly there was a big wave and the ship they were riding hit a rock big enough that the boat was badly damaged and could not be repaired. Luckily, the five researchers could swim to reach the island's edge. The researchers sent a message to the SAR team asking for help. Unfortunately, the local SAR team does not have a helicopter but only a small boat. The SAR team also couldn't come to pick up immediately because of the big waves that were expected to last for a week. The researchers only had enough food and water supplies for one day. They also went around the island to look for food ingredients, but there was not a single plant or animal on the island that could be used as food, even though they had to survive another week. The SAR team decided to send food aid via paraglider.
Assignment	Design a ready-to-eat food product that will be delivered to researchers in two days! <ul style="list-style-type: none"> - consider the composition of food, pay attention to calories, nutrition, and nutrition - explain the packaging used to package the food you design

The study population was students of MTsN 15 Boyolali in grade 8. The population was 160 students from the same entire class at the VIII grade level of MTsN 15 Boyolali, who received the same learning time allocation and used the same 2013 Curriculum. The sample is students from one class in the class 8 study group cluster. The selected sample is class 8.A.1, with 18 students consisting of seven male and eleven female students. All students in the class became research respondents.

The data used are individual pretest-posttest scores. In addition, STEM product assessments were made in groups to see students' abilities in working on projects.

Data on the value of the STEM-ThingLink project was taken through the student worksheet instrument. Ten experts validated the student worksheet (LKS) instrument by scoring the statements in the validation questionnaire. The study's results were analyzed descriptively quantitatively by calculating the average score. The results of the test of the validity of the learning device research instrument showed the results were very valid with an average score of 3.67, so the learning device that had been prepared was declared to be able to be used as a research instrument.

Meanwhile, the pretest-posttest value data was used to measure the understanding

of the concepts taken through the question instrument. The pre-test and post-test instruments were five description questions. The questions asked in the pre and post-test were the same. The questions included measuring indicators of understanding the meaning of food, nutrition, and calories (one question), understanding indicators of categorizing food ingredients based on the type of nutrition (one question), indicators of understanding human calorie needs (one question), indicators of understanding eating patterns (one question), and indicators of understanding unhealthy eating patterns. The questions were validated by the Product Moment test using

SPSS 26. The basis for decision making is if r count $>$ r table (0.05), which is 0.444. The instrument reliability test used the Kuder Richardson-20 Test (KR-20). The validity test results stated that the decision was valid for the five questions tested and gave the results of five valid questions so that it could be used for research. Meanwhile, the reliability test of the pre-test and post-test instruments using the Kuder Richardson formula (KR 20) assisted by SPSS 26 gave a result of 0.985 or was in very high criteria. Thus, it can be concluded that the pre-test and post-test instruments used in the study were reliable.

RESULTS AND DISCUSSION

Table 2. STEM Project Results by Group

Group	Name of Food	Food Design Composition	Packaging
1	Bread	Flour 1kg, Sugar 50 grams, Milk 100 ml, Yeast	Plastic
2	Bakpia	Flour high protein, vegetable oil, green beans, sugar, pandan leaves, and coconut milk. The content contained in food is carbohydrates (sugar), protein (protein flour and green beans), fat (coconut milk, oil)	Plastic
3	Oat Bar	330 grams of oat porridge, six spoons of golden syrup, a pinch of salt, ginger, butter	Plastic dan alumunium foil
4	Corn Dog	330 grams of oat porridge, six spoons of golden syrup, a pinch of salt, ginger, butter, sausage	Plastic dan alumunium foil

Table 2 shows the recapitulation of students' STEM-ThingLink project results.

The project results were then assessed according to the rubric listed in Table 3.

Table 3. STEM Product Rating Rubric

Aspect	Score		
	1	2	3
Originality	if the idea for the ingredients used is taken from someone else's idea without any modification	if the idea for the ingredients used is taken from someone else's idea with a slight modification from the students	if the idea for the food ingredients used comes from your thoughts
Valuable	nutritional composition and nutrition are incomplete and do not follow the calorie requirement	nutritional composition and complete nutrition but not following the number of calorie needs	nutritional composition and complete nutrition, and following the number of calorie needs

Aspect	Score		
	1	2	3
Useful	the weight of the food is more than one kg, and the food can only last for one day	the weight of the food is not more than one kg, and the food can last for 2-3 days	the weight of the food is not more than one kg, and the food can last for 4-7 days
Well-crafted	if the packaging is toxic, the size and material are not suitable for the food, and the packaging is not easy to recycle	if the packaging is not toxic, the size and material are suitable for the food, but the packaging is not easy to recycle	if the packaging is not toxic, the size and material match the food, and the packaging is easy to recycle

Table 4. Group STEM Project Score

Group	Aspect				Score
	Originality	Valuable	Useful	Well crafted	
1	1	3	2	3	60.00
2	1	2	3	3	66.66
3	1	1	3	3	53.33
4	1	2	2	3	53.33

The STEM project value data in Table 4 is then interpreted according to the creativity scale. The results of students' STEM project scores and creative thinking skills can be good. If viewed from the list of values, all groups have low originality aspect values. The average food designs made by students are not the result of their thinking or copying from the types of food that already exist, and they usually find around. As for the valuable aspect, only one group scores high. The other three groups get moderate and low scores. For the useful aspect, the group's average score is moderate and high. For the well-crafted aspect, the entire group has a high score, so overall, students' creativity is considered adequate and good.

Many factors can cause the low value of some aspects of student creativity. To

hone students' creative thinking skills, it is necessary to introduce challenging problems and provoke students to think. Meanwhile, although many materials support the creation of problems in science subjects, if learning is only limited to introducing the material, it will be difficult to feel student creativity. Another factor is that students have difficulty explaining the steps for solving problem cases (Arisanti, Sopandi, & Widodo, 2016).

The STEM approach is one solution that is considered to be able to improve or hone concept understanding. According to (Hidayanti, Rochintaniawati, & Agustin, 2018), the stages of STEM learning that can be used are giving opinions (brainstorming), solving a problem (creative problem solving), and applying project-based learning.

Table 5. Description of Pre-test and Post-test Scores

Description	Pre-test	Post-test
<i>N</i>	18.00	18.00
<i>Mean</i>	54.26	72.93
<i>Median</i>	53.30	80.00
<i>Mode</i>	53.00	80.00
<i>Standard deviation</i>	14.73	12.63
<i>Variance</i>	217.04	159.52
<i>Range</i>	53.00	40.00
<i>Minimum</i>	27.00	47.00
<i>Maximum</i>	80.00	87.00
<i>Sum</i>	977.00	1313.00

Table 5 is a statistical description of the pre-test and post-test scores, which compares the data description of the student's creative thinking skills before and

after treatment, which shows a significant difference. This supports the paired t-hypothesis test to test the statistics shown in Table 6.

Table 6. Test Results of the Effect of STEM Learning on Students' Conceptual Understanding

Sample	T-test		T _{table}	Ratio		Test results
	T _{count}	Sig		T value	Sig with α	
18	6.895	0.03	2.101	T _{count} \geq T _{table} 6.895 \geq 2.101	Sig < α 0.03 < 0.05	H ₀ rejected

Table 6 shows that the significance value (sig.) is $0.03 < 0.05$ and $T_{count} \geq T_{table}$, so H₀ is rejected, or the pre-test and post-test values are significantly different. From the results of hypothesis testing and the average pre-test and post-test scores, the STEM-ThingLink learning positively influences the creative thinking skills of 8th-grade students of MTsN 15 Boyolali in the 2020/2021 school year.

Suppose in the results of hypothesis testing there is a significant difference in the results of students' scores between before and after treatment, which is strengthened by an increase in the mean value. In that case, an assumption is drawn that STEM learning positively affects students' understanding of concepts. Several factors that support this positive influence are STEM education motivates students to increase interest so that students become more interested in learning (Stohlmann et al., 2012).

CONCLUSIONS AND SUGGESTIONS

Based on the data, there is a gap between the average pre-test and post-test scores. Therefore, the STEM-ThingLink learning design positively affects students' understanding of the concept of nutrition, especially for eighth-grade students. The STEM approach in the classroom presents new experiences for students, which may motivate them to know the concepts deeply and apply them in the contextual format.

The limitation of this research lies in the small number of samples and the stage of STEM product assessment (no interim

assessment and final assessment). Therefore, more experimental research with larger sample classes and a longer period of STEM application should be done to map students' creative thinking skills during STEM learning.

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