Inovasi Matematika (Inomatika)
Vol.5 No.1, Januari 2023, hal.58 – 84
DOI: 10.35438/inomatika.v5i1.360
https://inomatika.unmuhbabel.ac.id/index.php

Promoting Students' Creative Thinking Through Activities Exploring The Surrounding Nature: A Stem Project-Based Learning Design For Sets

Adinda Salshabilla Yudha[1], Helen Novi Antika[2], Erina Ellen Rusmana[3], Ahmad Wachidul Kohar[4*]

[1,2,3,4]Pendidikan Matematika, Universitas Negeri Surabaya, Indonesia
*ahmadkohar@unesa.ac.id

Abstrak

Penelitian ini bertujuan untuk mendeskripsikan proses dan hasil dari pengembangan perangkat pembelajaran berbasis PjBL terintegrasi STEM-Jelajah Alam Sekitar (JAS) untuk meningkatkan kemampuan berpikir kreatif siswa pada materi himpunan. Penelitian ini merupakan penelitian pengembangan dengan model pengembangan Plomp untuk mengembangkan perangkat pembelajaran berupa Modul Ajar dan Lembar Kerja Proyek materi himpunan dengan desain pembelajaran proyek terintegrasi STEM-JAS. Uji coba dilakukan pada siswa kelas 7 sebanyak 31 siswa pada sebuah SMP di Surabaya, Jawa Timur. Teknik pengumpulan dan analisis data dilakukan menggunakan lembar validasi untuk mengetahui kevalidan perangkat pembelajaran yang diujikan pada validator. Penggunaan lembar pre-test dan post-test digunakan untuk mengukur efektivitas terkait kemampuan berpikir kreatif siswa pada materi himpunan. Selain itu, lembar respons siswa juga digunakan untuk mengetahui kepraktisan perangkat pembelajaran yang telah dikembangkan. Hasil penelitian menunjukkan bahwa perangkat pembelajaran memeroleh kriteria kevalidan sebesar 92,5% untuk Lembar Kerja Proyek sedangkan 91,25% untuk validitas Modul Ajar dan masing-masing tergolong sangat valid. Untuk kriteria keefektifan diperoleh N-gain 0,7512 pada uji coba terbatas dan 0,71 pada uji coba kelas dan masing-masing memeroleh kriteria efektivitas yang tinggi. Perangkat pembelajaran memeroleh kriteria sangat praktis diimplementasikan dengan rata-rata perolehan respons siswa sebesar 85% dan 84% untuk desain pembelajaran proyek.

Kata kunci: Himpunan, Keterampilan Berpikir Kreatif, Perangkat Pembelajaran PjBL terintegrasi STEM-JAS

Abstract

This study aims to describe the process and results of the development of STEM-Surrounding-Nature-Exploration (SNE) integrated with PjBL-based learning materials to improve students' creative thinking skills on sets concepts This is developmental research using the Plomp model to develop learning materials in the form of Teaching Modules and Project Worksheets for set materials with a STEM-SNE integrated project learning design. The trial was conducted on 31 grade 7 students at a junior high school in Surabaya, East Java. Data collection and analysis techniques were carried out using validation sheets to determine the validity of the learning materials tested on the validator. A pre-test and a post-test were used to measure effectiveness related to students' creative thinking on set material. In addition, student response sheets were also used to determine the practicality of the learning materials. Results found that the learning device obtained a validity criterion of 92.5% for the Project Worksheet while

91.25% for the validity of the Teaching Module and each was classified as very valid. For effectiveness criteria, it was obtained n-gain of 0.7512 in the limited trial and 0.71 in the class trial and each of them obtained high effectiveness criteria. Learning materials obtain very practical criteria implemented with an average student response acquisition of 85% and 84% for project learning designs.

Keywords: Creative Thinking, Set, STEM-SNE integrated PjBL-based learning

INTRODUCTION

In the 21st century, there are four basic abilities that students must have, namely 4C which includes critical thinking, creative thinking, communication, and collaboration. One of the most important is creative thinking skills because these skills are a way to produce ideas or ideas to be applied in the real world. The ability to think creatively is the ability to think accustomed and trained for turn on the imagination, reveal new possibilities by opening a broad perspective to find new ideas (Suripah & Sthephani, 2018). According to Marliani (2015), the ability to think creatively is an activity to produce an idea or ideas in solving problems and connecting one thing with another to find meaning. The perspective of mathematical creative thinking refers to a combination of logical and divergent thinking on the basis of situations but has a conscious goal (Isdiarti, 2022).

The development of student's creative thinking is essential to prepare students for future challenges and help them solve problems (Yunita et al., 2020). In learning mathematics, creative thinking is also important for students since it is argued that learning mathematics requires creative thinking. This skill is required in learning mathematics or what is referred to as mathematical creative thinking skills. Hamzah (in Soeviatulfitri & Kashardi, 2020) explains that the ability to think creatively mathematically is the ability to use a thinking process for a problem based on rational concepts and principles. The ability to think creatively mathematically can be interpreted as the ability to solve mathematical problems with more than one solution (Kozlowski et al., 2019), whose aspects used to assess one's creative thinking are fluency, flexibility, elaboration, and originality.

The fluency aspect refers to the ability to create a myriad of ideas, where the more ideas the more creative one's thinking becomes. Flexibility, on the other hand, describes the individual's ability to view a particular problem from various perspectives. Meanwhile, the elaboration aspect is defined as a bridge to communicate creative ideas that exist within oneself and the originality aspect refers to the uniqueness of any response that is unique and rare (Darwanto, 2019). Students who could think creatively can think fluency raises a lot of ideas and answers in solving problems; think flexibly (*flexibility)* which includes producing varied answers; original thinking (*originality*), namely being able to produce unique answers and being able to think of unusual ways; think elaboration that is developing ideas by adding or detailing an idea (Putra et al., 2018).

Unfortunately, based on the results of previous research, students' creative thinking skills are low. According to Andiyana et al. (2018), students' creative thinking abilities do not develop properly because the learning process in class does not involve students. The role of students tends to be passive, so it hinders the development of creativity and student activity. Students find it difficult to express their ideas and ideas in learning mathematics. One of them is in set material, where students experience many difficulties including difficulties in understanding concepts, recognizing and understanding symbols, and solving problems in set operations (Nurjanah et al., 2020). The concepts are around writing errors in the form of a member symbol of the set and are expressed in a Venn diagram. Students also have difficulty identifying symbols related to sets, such as combinations of "∪" and slices of "∩". In addition, they also have difficulty performing combined set operations. According to Pratiwi & Khotimah (2016), the difficulties experienced by students with set material were difficulty understanding questions, transforming questions, and solving problems.

In research conducted by Adilistiyo et al. (2017) regarding the analysis of student errors in solving questions on set material, the result was that the errors experienced by students in solving set problems were misunderstanding, solution process errors, and conclusion errors. Factors that cause errors include students' low understanding of reasoning and understanding set material questions, lack of accuracy in completing arithmetic operations, unsystematic work steps, lack of self-training on math problems, not being used to writing conclusions, and students’ inability to interpret solutions into real-world contexts.

Not only experience difficulties and errors, but students also experience misconceptions related to set material. There are several forms of misconceptions experienced by students based on research from Nurtasari et al. (2017). These forms were related to the overgeneralization of misconceptions experienced by students such as students stating that a set always has elements, a set does not have to have clear properties, a combination of sets A and set B is a combination of the two elements A and B, an intersection is a set that is a different element of set A and set B, the elements of the universe of speech are all written on the Venn diagram, and the elements of the universe of conversation do not need to be written on the Venn diagram. The form of specialization misconceptions experienced by students such as students stating that the presentation of Venn diagrams related to combinations such as subsets, the presentation of Venn diagrams related to combinations is always mutually exclusive, and the combination is a universal set. Meanwhile, this research also found that the forms of notational misconceptions experienced by students include students stating that $' \subset\ '$ (subset) is an intersection, and element ‘a’ of set A, for example, means that there is an element of set A.

From this description, students’ creative thinking skills are classified as low in set material. In addition, the set is relatively new material, so it is difficult for students to understand. Students also still have difficulty working on the types of HOTS questions within the scope of the set that requires students' creativity in thinking (Syahnaz, 2021). Based on these conditions, there is a need for student-centered mathematics learning innovations to give them the opportunity to promote their creative thinking skills.

One of the learning models that can be used to provide students with opportunities in promoting creative thinking skills is project-based learning (PjBL) (Darmadi et al., 2021). The PjBL learning model involves the contribution of students in learning activities because they play an active role in making projects. One of the suitable learning designs for PjBL is STEM *(Science, Technology, Engineering, and Mathematics)*. In project-based learning, students can understand concepts through product creation, whereas in STEM learning students will carry out the process of designing and designing products (Lutfi et al., 2018). The PjBL model that is integrated with STEM gives students the freedom to explore learning activities, carry out projects collaboratively, and produce solutions that are solutive and creative (Rais in Lutfi et al., 2018).

Research shows that the STEM learning approach influences students' creative thinking (Sirajudin & Suratno, 2021; Sumarni & Kadarwati, 2020). Another study conducted by Ameer et al. (2021) that the STEM learning approach in addition to increasing students' creative thinking also increases students' mathematics learning achievement. With the STEM approach, students learn to connect four fields namely science, technology, engineering, and mathematics so that they are able to generate new ideas and create original works that have not existed before through experimentation, and practical practice which is one of the skills of creative thinking. A further study conducted by Yulianti et al. (2020) also showed that there was an increase in creative and critical thinking in students with STEM-based student worksheets. Also, their research also showed that learning by using STEM-based worksheets could also increase students' mathematics content knowledge, which can be acquired not directly by rote, but instead through the process of meaningful learning.

STEM learning can be integrated into learning mathematics and has an important role, namely modeling mathematics, numeracy, and socio-scientific issues, as well as other relevant skills in the 21st century, especially how to think creatively, think critically, solve problems, and make decisions (Maass et al., 2019). Mathematics, in this learning design, has a role to play in STEM learning such as understanding patterns and relationships and providing a language for technology, science, and engineering. According to Fitzallen (2015, pp. 237–244), mathematics has roles to support other disciplines in STEM learning by prioritizing students' content acquisition to particular concepts. The next role of mathematics in STEM is to make something learned easy to understand (Li & Schoenfeld, 2019). That is, mathematics in STEM can make learning more meaningful so that students are able to gain. In relation to STEM-based worksheets, the role of mathematics can vary depending on the learning objectives of the learning using such kinds of the worksheet. It can be used to figure out and make predictions about real-life applications as well as modeling activities toward real-world situations mathematically, which is central to effective STEM learning (Maass et al, 2019), or address complex phenomena or situations through tasks requiring students to employ knowledge and skills from various disciplines as the context for learning particular contents in mathematics (Martín-Páez et al, 2019).

There is a well-known series of steps that engineers follow to come up with a solution to a problem, namely Engineering Design Process (EDP), which is used to inspire STEM learning design (Sumarni & Kadarwati, 2020). EDP is known to play an important role in the product design and design process. With the EDP, students can collect many problem-solving ideas to produce a product through several processes (English & King, 2015). There are five EDP processes, namely 1) Problem Scoping; 2) Idea Generation; 3) Design and Construct 4) Design Evaluation; 5) Redesign. Activities carried out include understanding the context of the problems used in the project, brainstorming or thinking of problem-solving strategies, developing models, testing models, and testing models. EDP is a series of stages carried out by researchers and designers in designing with an engineering background (Lin et al., 2015). It provides a real-world context to connect the disciplines of mathematics, technology, engineering, and mathematics that are inseparable from the real world to equip students to solve real problems (Firdaus et al., 2020). It is also an essential process required across STEM disciplines and allows students to appreciate how various ideas, approaches, and tools can be applied to complex problems involving more than one solution (English & King, 2015). The EDP stages are illustrated in Figure 1.

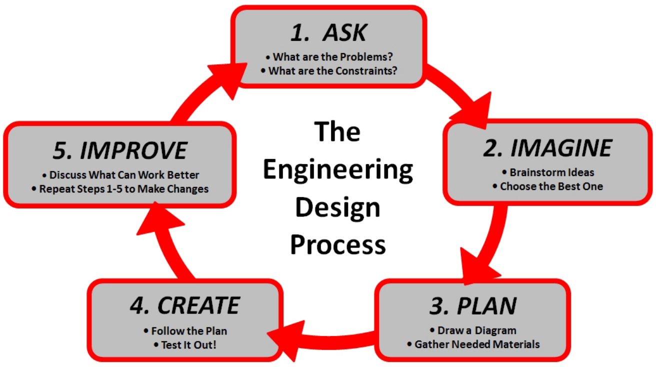


Figure 1 Process in EDP

Based on this figure, the following is a description of each aspect of EDP according to Syukri et al. (2017):

a. *Ask*

At this stage, students in their groups identify and analyze a given problem. Student limits and criteria for solutions according to the problem given.

b. *Imagine*

At this stage, students exchange ideas about various possible solutions to answer the problem. Students can conduct research through various sources of information that they think is relevant to assist them in developing various solution ideas. Of the various possible solutions, students in their groups determine the best solution to be offered.

c. *Plan*

By determining the best solution, the next step is to model the solution in a design or sketch of a concrete picture of the solution offered. In this design, students should be able to explain the parts of the design, the related functions of these parts, the materials used, and how their solution design will be able to answer the problem.

d. *Create*

Furthermore, using the specified materials, in their groups, students arrange products exactly according to the results of the designs/sketches they have compiled.

e. *Improve*

At this trial stage students will find out whether the solutions they design can answer the problems or challenges given at the beginning.

Research conducted by Hafiz & Ayop (2019) shows that the use of EDP is effective in STEM learning, as indicated by their selection of 37 articles related to the use of EDP in STEM learning and then systematically reviewing 5 stages to extract the effectiveness of EDP in the school environment. Subsequent research was conducted by English (2015) on grade 4 students through aerospace engineering problems, namely redesigning 3D model airplanes using engineering design in STEM learning showing that students are actively involved and can complete the initial design and redesign of model airplanes at various levels of sophistication. This shows that EDP has potential in STEM-based PjBL.

In STEM learning, students need to make observations as one of a series of project problem-solving strategies. Observations can be made by giving attention to the area around. Therefore, this learning can be integrated with the Surrounding Nature Exploration (SNE) approach which this approach utilizes the surrounding natural environment including the physical, social, technological, or cultural environment as learning objects. Learning mathematics by utilizing the surrounding natural environment can create learning activities that emphasize active involvement such as students being able to explore, try, discuss, and other activities that can reveal a phenomenon that occurs in nature. This is in line with one of the principles of quality learning, namely that students are actively involved intellectually and emotionally in exploring natural phenomena (Syamsi, 2014). Through quality learning, students' creative power can develop for the better if guided to work hard, enthusiastic and confident. Learning by involving nature as a context can increase student intelligence and make it adaptable to the environment (Tulalessy, 2018). One example of a mathematical concept that can be taught to students by utilizing the natural surroundings is set material. Students are given concrete objects that exist in nature and then grouped based on the nature and characteristics of these objects. Furthermore, according to S & Xaverius (2020), this SNE approach can improve students' skills to find and develop facts about a concept. This can encourage students to develop information based on the process of exploration and investigation. If the STEM approach is integrated with SNE, it can enable students to learn various concepts by opening broad insights into thinking (S & Xaverius, 2020).

From the explanation above, the authors initiated the development of STEM-SNE integrated PjBL-based learning materials to improve students' creative thinking skills on set material. This development was developed using the Plomp model because the stages are in accordance with the goals in developing educational tools. In this case, the development of learning materials in the form of STEM-SNE integrated PjBL-based lesson plans and worksheets.

METHOD

This research is a type of development research that is used to develop a product in the field of education to produce a product and test its effectiveness (Saputro, 2017). The development model used in this study is the Plomp development model with five phases, namely the Initial Investigation Phase, the Design Phase, the Realization/Construction Phase, and the Test, Evaluation, and Revision Phases. The Plomp model is used because it is suitable for developing teaching tools. Based on the Plomp development model, the research procedures carried out are:

1. Initial Investigation Phase

   At the initial investigation stage, the activities carried out were a needs analysis for the development of STEM-based mathematics learning materials, namely:

   a. Determine the basic competence of the target material, namely set material in class VII SMP. This material was chosen because it is classified as new material that is learned by students in class VII and requires a comprehensive understanding.

   b. Determine the STEM-SNE (*Science, Technology, Engineering, Mathematics* – Surrounding Nature Exploration) learning design related to set material.

2. Design Phase

   After analyzing the initial needs for the development of learning materials, teaching materials were designed by collecting learning device data for teaching modules and STEM-SNE-based Project Worksheets. Stages in the design phase, including:

   a. STEM learning design

      In the STEM learning design, what is done is to determine STEM-SNE activities and create an activity framework. The STEM-SNE activity developed is **"HERBARIUM ALBUM: Green Open Spaces Around You"**. This activity is carried out by observing the surroundings using the SNE approach.

   b. Determine the STEM aspect of learning activities

      In the activities that have been determined, STEM aspects can be explained in the following Table 1.

Table 1. STEM Components and Payload

No	STEM components	STEM payload
1	*Science*	Classification of plants
2	*Technology*	Herbarium Albums
3	*Engineering*	Techniques for making herbarium albums: drying plant specimens, cutting and pasting.
4	*Mathematics*	Set concept

c. Define EDP (*Engineering Design Process*)

Engineering design process is an important stage in STEM learning activities. Where, EDP is one of the strategies in implementing STEM learning. In this activity, the EDP carried out in the STEM-SNE integrated PjBL learning activities is described in Table 2:

Table 2. Aspects of EDP

No	EDP aspect	Description
1	*Ask*	Ask questions to students about how plant researchers can find out the names and uses of plants in the past? How to document?
2	*Imagine*	Ask students to think of a solution to the question. Together they think about a solution that is practical and practical to document plant specimens from different divisions.
3	*Plan*	Make a diagram or design the required herbarium album. Also agreed on a production schedule.
4	*Create*	At this stage, students begin to realize the herbarium album that has been designed. In the SNE aspect, they will explore the surroundings to find out which specimens will be used to make a herbarium album.
5	*Improve*	Reflect on the herbarium album that has been done. Is it functional? Or is there anything that needs fixing.

3. Realization/Construction Phase

The next stage is realizing or constructing learning materials in the form of teaching modules and worksheets. Materials development was carried out according to the design that was originally made. In addition, in this phase research instruments were also developed in the form of validation sheets, student questionnaires, and observation sheets.

4. Test, Evaluation, and Revision Phases

After the learning materials have been developed, the researcher will test the results of the device development to the validator to find out whether the teaching modules and worksheets are feasible to be tested on students. The validator in question is the set material validator and the STEM component. After being declared valid by the validator, the product in the form of a learning device will also be tested on a limited basis to students. Trials were carried out to determine the feasibility and suitability of learning materials by providing student response questionnaires to learning designs according to teaching modules and worksheets. In addition, observations were also held for students to find out the increase in creative thinking skills.

This research was conducted in one of the junior high schools in Surabaya by taking a population of grade 7 students who had not received set material. Data collection was carried out using two learning trial designs, namely limited trials and class trials. For a limited trial, six students were selected with two students each having high, medium, and low mathematical abilities. As for the class tryout, it was conducted with a sample of 31 people consisting of 17 male students and 14 female students.

RESEARCH RESULTS

The process of developing learning materials refers to the Plomp development model which consists of the Initial Investigation Phase, the Design Phase, the Realization/Construction Phase, and the Test, Evaluation, and Revision Phases (Plomp & Nieveen, 2013). In the initial investigative phase, what was done was conducting an analysis of learning needs by observation. In the design phase, what was done was to determine the STEM learning framework for set learning. In addition, an EDP (*Engineering Design Process*) design was also carried out for each learning device. For the realization/construction phase, learning materials and research instruments were developed. In the test, evaluation, and revision phases, a validity test is carried out on the validator and when it meets validity, it is continued by carrying out limited trials and class trials to determine the effectiveness of learning materials. Finally, to retrieve the practicality of the learning device, use student response sheets.

In the initial investigation phase, some results were obtained from observations and interviews with a grade 7 math teacher at a school in Surabaya regarding previous set learning. The teacher states that the set material is presented by giving an explanation from the teacher and discussed together. Set lessons have never been carried out with project learning and have never carried out integrated learning with other subjects. Set material is also one of the materials that are difficult for students to understand. Therefore, the selection of research topics by carrying out STEM-SNE integrated PjBL mathematics learning in set material was proposed in the target schools.

In the design phase, the researchers construct the design and framework for STEM learning. The main activity carried out is the Herbarium Album Project by grouping the surrounding plants associated with set material in mathematics. Initially, the title of this project activity was "The Herbarium Album Project for Grouping Plants" which in its development changed to "HERBARIUM ALBUM: Green Open Spaces Around You." Because it is considered more relevant to life.

Figure 2. Aspects of EDP *Ask*

The EDP *Ask aspect* contained in the LKP in Figure 2, which is related to questions students need to think about regarding the concept of green open spaces which are then linked to the issues raised in this project.

Tugas

Ruang Terbuka Hijau (RTH) merupakan area memanjang atau berkelompok yang penggunaannya terbuka sebagai tempat tumbuh tanaman baik yang ditanam dengan sengaja maupun tidak. Di era modernisasi, RTH sangat diperlukan untuk menjaga keseimbangan alam serta meningkatkan mutu lingkungan khususnya di perkotaan. Salah satu RTH di Indonesia, yakni Kebun Raya Purwodadi yang berlokasi di Pasuruan, Jawa Timur. Selain sebagai RTH, Kebun Raya Purwodadi juga berfungsi sebagai balai konservasi tumbuhan secara *ex situ*. Koleksi tumbuhan di Kebun Raya Purwodadi cukup beragam dan dikelompokkan berdasarkan varietasnya.

Gambar 1 Kebun Raya Purwodadi

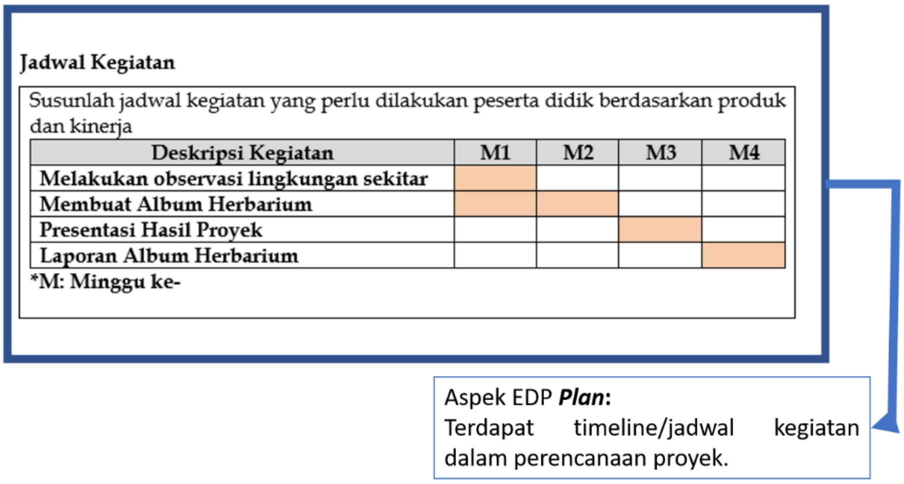
Sekarang coba amati lingkungan di sekitarmu, apakah di sekitarmu terdapat RTH? Bagaimanakah karakteristik tumbuhan yang ada di lingkungan tempat tinggalmu? Coba dokumentasikan tanaman-tanaman tersebut dengan membuat album herbarium bersama teman kelompokmu (4-5 orang). Buatlah album herbarium dengan minimal lima pengelompokan tumbuhan berdasarkan jenis tulang daun/jenis akar/jenis batang/dsb. Kemudian, berikan pendapatmu apakah daerah sekitarmu dapat dikatakan sebagai RTH dengan mempertimbangkan jenis tumbuhan yang telah kamu buat dalam album herbarium. Diskusikan bersama kelompokmu!

Gambar 2 Album Herbarium

Aspek EDP ***Imagine***:
Peserta didik diberi gambaran atau solusi pertanyaan masalah pada aspek *Ask* dengan membuat album herbarium sebagai salah satu cara mengetahui RTH di sekitarnya.

Figure 3. Aspects of EDP *Imagine*

The EDP *Imagine aspect* contained in LKP in Figure 3, which is related to the direction of solving or solving problems raised in STEM learning. Where, to determine the quality of a land can be seen by the characteristics of the plants that grow. To document these plants, a herbarium album was made with groups of plants that had been dried.



Jadwal Kegiatan

Susunlah jadwal kegiatan yang perlu dilakukan peserta didik berdasarkan produk dan kinerja

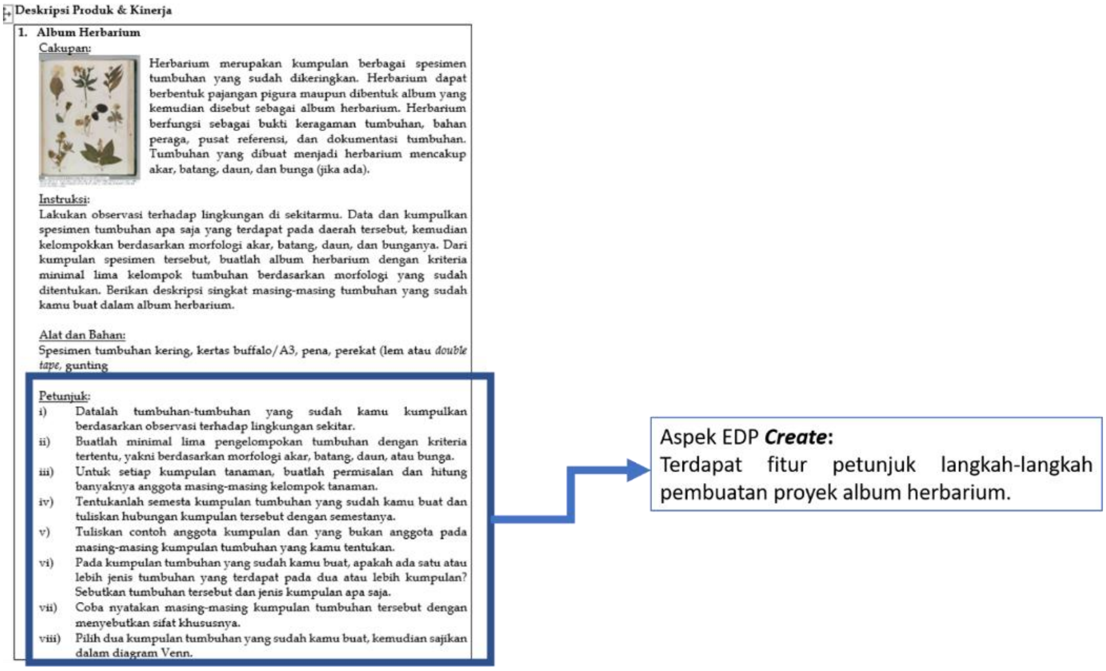
Deskripsi Kegiatan	M1	M2	M3	M4
Melakukan observasi lingkungan sekitar				
Membuat Album Herbarium				
Presentasi Hasil Proyek				
Laporan Album Herbarium				

*M: Minggu ke-

Aspek EDP ***Plan***:
Terdapat timeline/jadwal kegiatan dalam perencanaan proyek.

Figure 4. Aspects of the EDP *Plan*

The EDP *Plan aspect* listed in the LKP in Figure 4 is the preparation of a timeline of activities related to the implementation of the STEM project in the picture above. The project implementation plan is described according to the activities and the deadline for implementing the activities.


Deskripsi Produk & Kinerja

1. Album Herbarium

Cakupan:

Herbarium merupakan kumpulan berbagai spesimen tumbuhan yang sudah dikeringkan. Herbarium dapat berbentuk pajangan pigura maupun dibentuk album yang kemudian disebut sebagai album herbarium. Herbarium berfungsi sebagai bukti keragaman tumbuhan, bahan peraga, pusat referensi, dan dokumentasi tumbuhan. Tumbuhan yang dibuat menjadi herbarium mencakup akar, batang, daun, dan bunga (jika ada).

Instruksi:

Lakukan observasi terhadap lingkungan di sekitarmu. Data dan kumpulkan spesimen tumbuhan apa saja yang terdapat pada daerah tersebut, kemudian kelompokkan berdasarkan morfologi akar, batang, daun, dan bunganya. Dari kumpulan spesimen tersebut, buatlah album herbarium dengan kriteria minimal lima kelompok tumbuhan berdasarkan morfologi yang sudah ditentukan. Berikan deskripsi singkat masing-masing tumbuhan yang sudah kamu buat dalam album herbarium.

Alat dan Bahan:

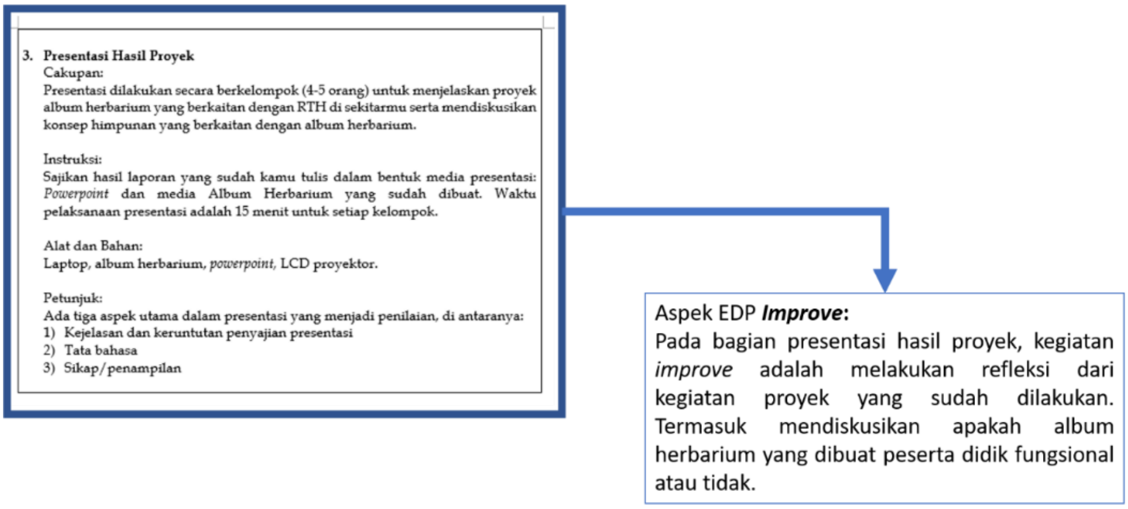
Spesimen tumbuhan kering, kertas buffalo/A3, pena, perekat (lem atau *double tape*, gunting

Petunjuk:

i) Datalah tumbuhan-tumbuhan yang sudah kamu kumpulkan berdasarkan observasi terhadap lingkungan sekitar.
ii) Buatlah minimal lima pengelompokan tumbuhan dengan kriteria tertentu, yakni berdasarkan morfologi akar, batang, daun, atau bunga.
iii) Untuk setiap kumpulan tanaman, buatlah permisalan dan hitung banyaknya anggota masing-masing kelompok tanaman.
iv) Tentukanlah semesta kumpulan tumbuhan yang sudah kamu buat dan tuliskan hubungan kumpulan tersebut dengan semestanya.
v) Tuliskan contoh anggota kumpulan dan yang bukan anggota pada masing-masing kumpulan tumbuhan yang kamu tentukan.
vi) Pada kumpulan tumbuhan yang sudah kamu buat, apakah ada satu atau lebih jenis tumbuhan yang terdapat pada dua atau lebih kumpulan? Sebutkan tumbuhan tersebut dan jenis kumpulan apa saja.
vii) Coba nyatakan masing-masing kumpulan tumbuhan tersebut dengan menyebutkan sifat khususnya.
viii) Pilih dua kumpulan tumbuhan yang sudah kamu buat, kemudian sajikan dalam diagram Venn.

Figure 5. Aspects of EDP *Create*

The EDP *Create aspect* of LKP in Figure 5 is contained in the activity instructions for making a herbarium album. The process or steps of project implementation are carried out in the instructions for each activity description.


3. Presentasi Hasil Proyek

Cakupan:

Presentasi dilakukan secara berkelompok (4-5 orang) untuk menjelaskan proyek album herbarium yang berkaitan dengan RTH di sekitarmu serta mendiskusikan konsep himpunan yang berkaitan dengan album herbarium.

Instruksi:

Sajikan hasil laporan yang sudah kamu tulis dalam bentuk media presentasi: *Powerpoint* dan media Album Herbarium yang sudah dibuat. Waktu pelaksanaan presentasi adalah 15 menit untuk setiap kelompok.

Alat dan Bahan:

Laptop, album herbarium, *powerpoint*, LCD proyektor.

Petunjuk:

Ada tiga aspek utama dalam presentasi yang menjadi penilaian, di antaranya:
1) Kejelasan dan keruntutan penyajian presentasi
2) Tata bahasa
3) Sikap/penampilan

Figure 6. Aspects of EDP *Improve*

The EDP *Improve aspect* of LKP in Figure 6 is found in the Project Results Presentation activity section where in this activity, students and teachers will carry out reflection activities on learning activities and the projects they have created together. In addition to designing the EDP for learning materials, what is being done in this phase is designing *pre-test* and *post-test questions* to find out the improvement in students' creative thinking aspects. The questions developed are five questions that can measure four categories of students' creative thinking. In addition to the *pre-test* and *post-test* instruments, the researcher also designed validation instruments and student responses to collect information related to the validity of the learning materials and how students responded to the implementation of project learning.

In the realization/construction phase, learning materials are developed according to the plans made in the design phase. The activities carried out in this phase, namely 1) Discuss learning indicators for making learning materials, 2) Develop teaching modules as a reference for making Project Worksheets, 3) Develop Project Worksheets, 4) Develop *pre-test* and *post-test instruments* , 5) Develop learning device validation instruments, and 6) Develop student response instruments.

In the test, evaluation, and revision phases, what was carried out was validating learning materials on validators, namely two mathematics department lecturers and mathematics teachers at target schools. After being validated and revised according to the input when validating, learning materials were tested on research objects. The research object was chosen because of the ability of mathematics which tends to be evenly distributed among students who have high, medium, and low mathematical abilities.

The results of the development of learning materials in terms of validity, practicality, and effectiveness. The results are described as follows:

A. Validity

The validity of the research instrument was carried out by validating the Project Worksheet and Teaching Module, which are learning materials, to two validators consisting of a mathematics education lecturer and a mathematics teacher at a junior high school in Surabaya. The results of the validation of learning materials were analyzed using quantitative descriptive and declared valid if they achieved a minimum validity criterion of ≥61.

a) Project Worksheet Validity

Table 3. Project Worksheet Validation Results

No	Assessment Aspects	Expert Assessment		Average	Criteria
		Validators I	Validators II		
1	Content Eligibility	87.5%	93.75%	90.625%	Very Valid
2	language used	90%	90%	90%	Very Valid
3	Serving	91.6%	100%	95.8%	Very Valid
4	Graphic	93.75%	93.75%	93.75%	Very Valid
	AVERAGE			92.5%	

In the validation process on Table 3, there are several inputs given by the validator even though the device is declared valid and suitable for use. Some of these things include adjusting the terms in the teaching modules and project worksheets according to the terms in the independent curriculum. Because there are several terms that still use terms in the 2013 curriculum that are irrelevant. In addition, the validator also provides input regarding some inappropriate writing. So, the step that the writer took then was to make minor revisions according to the input of the validators.

After validating the Project Worksheet and analyzing it, it was found that the results of the validity of the LKP on the content feasibility aspect obtained an average of 90.625% with very valid criteria. In the linguistic aspect, an average of 90% is obtained with very valid criteria. In the presentation aspect, an average score of 95.8% is obtained with very valid criteria, and in terms of graphics, an average score of 93.75% is also obtained with very valid criteria. It can be concluded that STEM-Based Project Worksheets can be used in Set learning.

b) Teaching Module Validity

Table 4. Teaching Module Validation Results

No	Assessment Aspects	Expert Assessment		Average	Criteria
		Validator I	Validators II		
1	Purpose	70%	90%	80%	Valid
2	Content Eligibility	80%	90%	85%	Very Valid
3	Language Use	100%	100%	100%	Very Valid
4	Time	100%	100%	100%	Very Valid

After validating the Teaching Module and analyzing it, it was found that the results of the validity of the LKP, Table 4, on the objective aspect obtained an average of 80% with valid criteria. In the feasibility aspect, the average content is 85% with very valid criteria. In the aspect of using language, obtaining an average score of 100% with very valid criteria, and when obtaining an average score of 100% also obtaining very valid criteria. It can be concluded that the STEM-Based Teaching Module can be used in Set learning.

B. Effectiveness

After going through the validation process, the next step is to implement the STEM learning materials in the learning that has been designed. There are two phases in implementing the learning tool, namely the limited trial phase and the class trial phase. Before starting learning with STEM-SNE integrated PjBL-based learning materials, students were asked to do *a pre-test* to find out their understanding of the set material before learning was carried out.

a) Limited trial phase

In the limited trial phase, six students were selected consisting of two students each with high, medium and low mathematical abilities. In the learning design, the six students were divided into two groups each consisting of one student with high, medium and low abilities.

From the *pre-test* , the results showed that students had low creative thinking skills with an average of 39.16. In the five *pre-test questions* given, two students with a high understanding of mathematics have a level of creative thinking *flexibility* for set material. The level *of flexibility* means that they can provide more varied answers with various points of view. In addition, the other four students had *fluency creative thinking levels,* which meant that they were still limited to giving common answers and less variety.

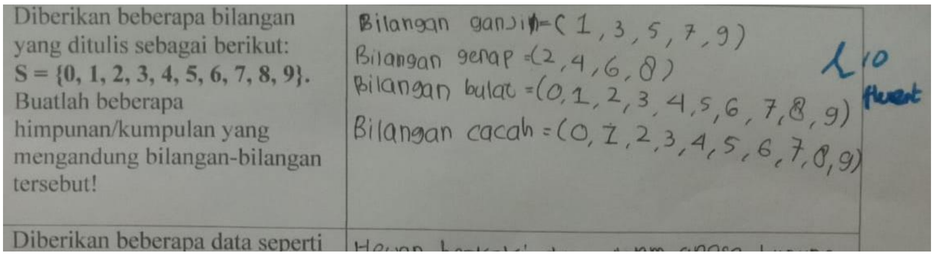
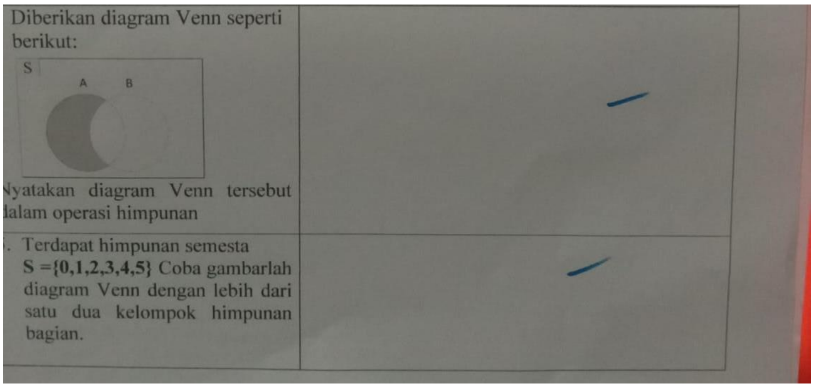


Figure 7 . Student AC *Pre-Test* Work

In working on the student AC*'s pre-test questions* according to the picture above, it is known that these students are at the level of *fluency* because the answers given are still general like their friends. In addition, the mention of sets is still general and does not pay attention to the given universe. Then, writing symbols is also inappropriate, namely using ordinary brackets instead of curly brackets to write set notation.



Diberikan diagram Venn seperti berikut: S A B Nyatakan diagram Venn tersebut dalam operasi himpunan	
Terdapat himpunan semesta S ={0,1,2,3,4,5} Coba gambarlah diagram Venn dengan lebih dari satu dua kelompok himpunan bagian.	

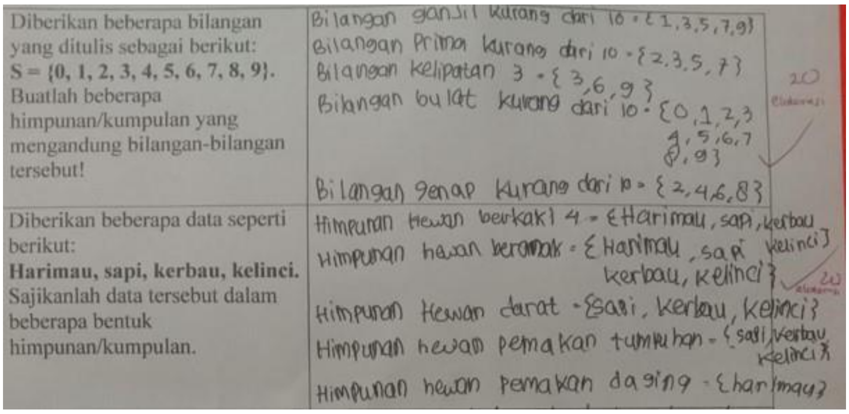
Figure 8 . AC Student *Pre-test* Work

In fact on Figure 8, for questions number 4 and 5, student AC did not fill in their work. He stated that he did not understand the purpose of the questions given and had difficulty doing them. This indicates that students do not even have fluency *in* working on questions. This case also happened to other students where they also had difficulty doing it.

From the results of the *pre-test*, it can be concluded that students' creative thinking abilities are still relatively low with the majority of creative thinking skills being at the *fluency stage*. In fact, there were some questions students could not complete at all. Then, the researcher implemented the learning materials in the STEM learning design in the limited trial group. The learning design is carried out within two weeks with five meetings as stated in the Project Worksheet.

After carrying out this study, the test students were again given *post-test questions* to determine students' creative thinking abilities while participating in STEM-SNE integrated project-based learning. The *post-test* results obtained an average of 84.16 which showed an increase of 48 points compared to *the pre-test*. The results of the level of creative thinking begin to increase, students begin to think from various perspectives (*flexibility*), then can provide answers that are original or rarely given by other students (*originality*), and at the highest level of creative thinking, that is, they can elaborate various alternative answers *(elaboration).).*

In working on *the post-test questions,* there was a significant increase in student AC after carrying out STEM-SNE integrated PjBL learning activities. If previously the questions he worked on were still limited to the *fluency level*, after participating in the PjBL STEM-SNE learning he succeeded in elaborating his thoughts on set material. Figure 9



Diberikan beberapa bilangan yang ditulis sebagai berikut: **S = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9}.** Buatlah beberapa himpunan/kumpulan yang mengandung bilangan-bilangan tersebut!	Bilangan ganjil kurang dari 10 = {1,3,5,7,9} Bilangan Prima kurang dari 10 = {2,3,5,7} Bilangan kelipatan 3 = {3,6,9} Bilangan bulat kurang dari 10 = {0,1,2,3,4,5,6,7,8,9} Bilangan genap kurang dari 10 = {2,4,6,8}	20
Diberikan beberapa data seperti berikut: **Harimau, sapi, kerbau, kelinci.** Sajikanlah data tersebut dalam beberapa bentuk himpunan/kumpulan.	Himpunan hewan berkaki 4 = {Harimau, sapi, kerbau, kelinci} Himpunan hewan beranak = {Harimau, sapi, kerbau, kelinci} Himpunan hewan darat = {Sapi, kerbau, kelinci} Himpunan hewan pemakan tumbuhan = {sapi, kerbau, kelinci} Himpunan hewan pemakan daging = {harimau}	20

Figure 9 . AC Student *Post-Test* Work

From this work, student AC combine other information to make a set and write it in a different form from their other friends. He presents a more varied answer clearly and completely.

Table 5. Calculation results of Limited Trial N-gain

Name	Pre-test	Post-test	N-gain
air conditioning	35	80	0.69231
AR	50	90	0.8
AAW	40	80	0.6667
CQAP	30	85	0.78571
MSB	20	75	0.6875
RAF P	60	95	0.875
Average			**0.7512**

The N-gain in this calculation (Table 5) is included in the high criteria, namely ≥0.7. These results indicate that the STEM-SNE integrated PjBL-based learning design is classified as effective in improving students' creative thinking skills on set material.

b) Class trial phase

After carrying out a limited trial phase with six students, the researcher conducted a class trial of 31 students. In the learning design, students are grouped into six groups consisting of 5-6 students. Before that, students were asked to do *a pre-test* which consisted of five questions to measure students' creative thinking abilities.

From the results of the *pre-test,* it was found that students still had low creative thinking skills with the majority of the average level of thinking possessed being *fluency* and there were several students who had a level of *flexibility creative thinking.* Then, the researcher conducted a two-week class trial related to the STEM-SNE integrated project-based learning design on set material consisting of six meetings. After conducting class trials, students were again asked to work on *post-test questions* to determine learning outcomes after carrying out project learning activities. From the results of the *post-test* , it is known that there is an increase in results after implementing STEM-SNE integrated project-based learning on set material. The average *post-test result* was 80.8 with an increase of 47 points.

After obtaining the results of the *pre-test* and *post-test,* the next step is to calculate the N-gain to determine the level of effectiveness of this learning. Based on each calculation, the N-gain results range from 0.5 to 0.9 for a total of 25 students. From these data, a final N-gain of 0.71 was obtained which was included in the high criteria, namely ≥0.7. These results indicate that the STEM-SNE integrated PjBL-based learning design is classified as effective in improving students' creative thinking skills on set material.

C. Practicality

a) Student Responses to Project-Based Learning "Album Herbarium"

Question	Percentage Analysis	Category
Learning The “Album Herbarium” project can motivate me to study set material	80%	Practical
Studying the "Album Herbarium" project can improve my understanding of the collection material	85%	Very Practical
Studying the "Album Herbarium" project is not interesting to do in learning	85%	Very Practical
Learning Project "Album Herbarium" helped me to think creatively on set material	85%	Very Practical
Learning Project "Album Herbarium" helps me in solving everyday problems on set material	80%	Practical
Learning Project “Album Herbarium” helps me to communicate problem solving ideas on set materials	82.5%	Very Practical
Learning the "Album Herbarium" project made it difficult for me to generate many ideas for solving the set material	85%	Very Practical

Learning the “Album Herbarium” project made it easy for me to apply set concepts to real-world contexts	87.5%	Very Practical
Herbarium ” project cannot relate the set material to problems in everyday life	87.5%	Very Practical
Studying the “Album Herbarium” Project did not add to my insight regarding the benefits of learning set material	85%	Very Practical
I prefer learning the “Album Herbarium” project more than just listening to the teacher's explanation	82.5%	Very Practical

b) Student Responses to the Practicality of the "Album Herbarium" Project Worksheet

Question	Percentage Analysis	Category
The “Album Herbarium” Project Worksheet is easy to use	90%	Very Practical
The text on the “Album Herbarium” Project Worksheet is legible	87.5%	Very Practical
The design of the “Album Herbarium” Project Worksheet is unflattering	85%	Very Practical
The questions in the “Album Herbarium” Project Worksheet are difficult to solve	85%	Very Practical
Herbarium ” Project Worksheet is easy to understand	82.5%	Very Practical
The images used in the “Album Herbarium” Project Worksheet support the clarity of the activity steps	80%	Practical
The printed image on the “Album Herbarium” Project Worksheet is not clearly visible	82.5%	Very Practical
The “Album Herbarium” Project Worksheet made it easy for me to study the set material	85%	Very Practical
The “Album Herbarium” Project Worksheet made it easy for me to think creatively about set	82.5%	Very Practical

material		
I do not like the "Album Herbarium" Project Worksheet used in learning set material	92.5%	Very Practical
The presentation of the material on the "Album Herbarium" Project Worksheet is very complete	87.5%	Very Practical

Based on the table above, it was found that the students' responses to the learning design and LKP in the majority of the statement items received very practical criteria in which STEM-SNE learning was practical to improve creative thinking skills.

DISCUSSION

Based on the results of this study, it was found that the STEM-SNE integrated PjBL-based learning tool can improve students' creative thinking skills in set material because it meets the criteria of validity, effectiveness, and practicality. The validity criteria were obtained by validating learning materials in the form of teaching modules and project worksheets on the validator and obtaining very valid criteria. Learning materials are also effectively implemented in learning because they can improve student learning outcomes on set material. Students who were previously limited to having a level of creative thinking in *fluency* or *flexibility* can achieve a level of *originality* and *elaboration* after participating in this learning. In addition, on practicality criteria, learning materials are considered practical by collecting data based on students' responses to project learning and the learning materials used.

This research is supported by several other studies with similar themes. For instance, another study entitled "Development of Mathematical Learning materials with the *Integrated Project Based Learning Model of Science Technology Engineering and Mathematics (STEM)* in Improving the Mathematical Reasoning Ability of Grade VII Middle School Students " obtained criteria of validity, effectiveness, and practicality (Oktadila et al., 2022). However, the distinguishing aspect of this research is that it only uses the STEM approach and learning materials with different activities, namely one-variable linear equations, and inequalities. While the research that will be developed, namely using STEM-SNE integrated PjBL on set material with the design of herbarium album-making activities to improve creative thinking skills.

Based on Indriani's research (2020) entitled "Improving Students' Mathematical Thinking Skills in Flat Shape Materials through the STEM Integrated Project Learning Model", STEM-integrated project-based learning can also improve mathematical thinking skills in flat shape material. The design of the project activity used is the design of a one-legged table model or a combination of triangular shapes by integrating several other disciplines. The differentiating aspects of the research being developed are the differences in material topics and the design of project activities. Another study entitled "STEAM PjBL-Based Polynomial Mathematics Learning Grows Student Creativity" states that the project design of making multi-purpose items from cardboard in the form of geometric shapes can foster student creativity (Ayuningsih, et al., 2022). The distinguishing aspects of this research are the PjBL STEAM approach, the topic of high school polynomial material, and the activity design. While the research developed used the STEM-SNE integrated PjBL approach, assemblage topics, and the design of making herbarium albums.

Based on research entitled "Effectiveness of Project Based Learning-STEM and Student Mathematical Problem Solving in Trigonometry Materials" states that PjBL-STEM learning has an influence on increasing the ability to solve mathematical problems in the topic of trigonometry (Priatna, Avip, & Sari, 2022). In this study, the activity design used was a project for making clinometer props to measure angles. The design of the activity is a differentiating aspect from the research developed on the topic of the set. In addition, based on Hadiyanti, et al., (2020), the use *of e-modules* with the STEM-PjBL approach can improve mathematical literacy skills on the topic of linear programming for vocational students.

In addition, another study entitled "Building Students' Mathematical Creative Thinking Skills with Integrated PjBL Learning with the STEM Approach" shows that STEM integrated project learning can increase student interest, make learning meaningful, and can build creative thinking skills.

In developing learning materials, the challenges faced are when determining and developing learning designs. This is because the PjBL learning model emphasizes contextual learning with complex activity designs, such as exploring, learning activities, collaborative, and producing a product (Sagala et al., 2019). Learning activities in PjBL are developed so that students are involved in iterative learning designs (discussing and obtaining *feedback*), bridging so that projects can help solve problems, and stimulate social construction and knowledge with contextual learning (Beneroso & Robinson, 2020). Therefore, there is a need for in-depth research related to the learning design used in designing projects in order to provide a contextual learning experience and involve students actively.

STEM instructional design should include all four disciplines even if it only focuses on one or two subjects to provide a project learning context. The context chosen must make students interested and motivated to do this learning (Khamhaengpol et al., 2021). According to Le et al. (2021) teachers must think about the right way to integrate STEM in teaching a context. In addition, another big challenge is how to assess project learning, planning time, and the content being taught. Therefore, it is important for researchers to plan the right content and context in designing learning so that students feel interested and actively involved in the project learning activities undertaken.

In addition, in integrating STEM aspects into project learning, it is necessary to consider the EDP (*Engineering Design Project*) aspect framework as a STEM learning strategy. This is because, according to Şahiner & Ünlü (2022), the EDP that is made must be clear and be able to bridge students in solving problems. The complete solution is clearly identified through the EDP and according to the specified criteria or boundaries. In addition, EDP can clearly show the steps that students must take in the learning process, and generalize alternative solutions to specific problems so that students can integrate knowledge in solving these problems. Mastery of the EDP concept in developing STEM learning is needed so that it can assist students in the process of solving problems through analysis, determining solutions, and modeling so that they can adjust problem-solving from some of the questions or problems given (Lin et.al, 2021)

So it can be concluded that STEM-SNE integrated project-based learning can improve creative thinking skills and mutually support the theory or previous research.

CONCLUSION

Based on the research that has been done, it can be concluded that the STEM-SNE integrated PjBL learning materials obtained have been validated with very valid criteria for each of the four categories in LKP and Teaching Modules. In terms of the implementation of the pre-test and post-test, the average N-gain is 0.58 which states that this learning tool is effectively implemented to improve creative thinking skills. The STEM-SNE integrated PjBL learning tool in terms of student response questionnaires obtained very practical criteria for implementation.

REFERENCE

Adilistiyo, Egie, M., & W., SH (2017). *Analysis of Class VII Middle School Students' Errors in Solving Problems on Set Material* (p. 4) [Thesis Thesis]. http://eprints.ums.ac.id/id/eprint/53599

Ameer, A., Majeed, B., & Alrikabi, H. (2021). The Impact of Teaching by Using STEM Approach in The Development of Creative Thinking and Mathematical Achievement Among the Students of The Fourth Scientific Class. *International Journal of*

Interactive Mobile Technologies (IJIM), 15 , 172–188. https://doi.org/10.399/ijim.v15i13.24185

Andiyana, MA, Maya, R., & Hidayat, W. (2018). Analysis Of Junior High School Students' Mathematical Creative Thinking Ability in Construction Materials. *JPMI (Journal of Innovative Mathematics Learning), 1* (3), 239–248. https://doi.org/10.22460/jpmi.v1i3.p239-248

Ayuningsih, F., Malikah, S., Nugroho, MR, Winarti, W., Murtiyasa, B., & Sumardi, S. (2022). PjBL STEAM-Based Polynomial Mathematics Learning Grows Student Creativity. *Basicedu Journal* , *6* (5), 8175–8187. https://doi.org/10.31004/basicdu.v6i5.3660

Beneroso, D., & Robinson, J. (2022). Online project-based learning in engineering design: Supporting the acquisition of design skills. *Education for Chemical Engineers* , *38* , 38–47. https://doi.org/https://doi.org/10.1016/j.ece.2021.09.002

Darmadi, Edy Suprapto, Ika Krisdiana, & Reza Kusuma Setyansah. (2021). *21st Century Mathematics Learning Innovation.* CV. AE Media Graphics.

Darwanto, D. (2019). Mathematical Creative Thinking Ability. *Exponent* , *9* (2), 20–26. https://doi.org/10.47637/eksponen.v9i2.56

English, LD, & King, DT (2015). STEM learning through engineering design: fourth-grade students' investigations in aerospace. *International Journal of STEM Education* , *2* (1). https://doi.org/10.1186/s40594-015-0027-7

Firdaus, AR, Wardani, DS, Altaftazani, DH, Kelana, JB, & Rahayu, GDS (2020). Mathematics learning in elementary school through engineering design process method with STEM approach. *Journal of Physics: Conference Series* , *1657* , 012044. https://doi.org/10.1088/1742-6596/1657/1/012044

Fitzallen, N. (2015). *STEM Education: What does mathematics have to offer?* (pp. 237–244). Mathematics Education Research Group of Australasia.

Hadiyanti, NFD, Hobri, Prihandoko, AC, Susanto, Murtikusuma, RP, Khasanah, N., & Maharani, P. (2021). Development of mathematics *e-module* with STEM-collaborative project based learning to improve mathematical literacy abilities of vocational high school students. *Journal of Physics: Conference Series* , *1839* (1), 012031. https://doi.org/10.1088/1742-6596/1839/1/012031

Hafiz, NRM, & Ayop, SK (2019). Engineering Design Process in Stem Education: A Systematic Review. *Human Resource Management Academic Research Society* , *9* (5), 676–697. https://doi.org/10.6007/IJARBSS/v9-i5/5998

Indriani, KW Ade. (2020). Increasing Students' Mathematical Thinking Ability In Flat Building Materials Through Stem Integrated Project Learning Models. *Mathematics Education Media* , *8* (1), 51. https://doi.org/10.33394/mpm.v8i1.2462

Isdiarti, F. (2022). Analysis of Creative Thinking Ability of Class VII Students of MTs Muhammadiyah Karangkajen Yogyakarta. *Proceedings of the Annual Conference on Madrasah Teacher* , *2* , 417–421. https://vicon.uin-suka.ac.id/index.php/ACoMT/article/view/1141

Khamhaengpol, A., Sriprom, M., & Chuamchaitrakool, P. (2021). Development of STEAM activity on nanotechnology to determine basic science process skills and engineering design processes for high school students. *Thinking Skills and Creativity* , 100796. https://doi.org/10.1016/j.tsc.2021.100796

Kozlowski, JS, Chamberlin, SA, & Mann, E. (2019). Factors that Influence Mathematical Creativity. *The Mathematics Enthusiast* , *16* (1-3), 505–540. https://doi.org/10.54870/1551-3440.1471

Le, LTB, Tran, TT, & Tran, NH (2021). Challenges to STEM education in Vietnamese high school contexts. *Heliyon* , *7* (12), e08649. https://doi.org/10.1016/j.heliyon.2021.e08649

Li, Y., & Schoenfeld, A.H. (2019). Problematizing teaching and learning mathematics as “given” in STEM education. *International Journal of STEM Education* , *6* (1). https://doi.org/10.1186/s40594-019-0197-9

Lin, K., Wu, Y., Hsu, Y., & John, WP (2021). Effects of infusing the engineering design process into STEM project based learning to develop pre-service technology teachers' engineering design thinking. *International Journal of STEM Education* , *8* , 1. https://doi.org/10.1186/s40594020002589

Lutfi, Ismail, & Azis, AA (2018). The Effect of Stem Integrated Project Based Learning on Scientific Literacy, Creativity and Student Learning Outcomes. *Proceedings of the National Seminar on Biology and Its Learning* , 189–194.

Maass, K., Geiger, V., Ariza, MR, & Goos, M. (2019). The Role of Mathematics in interdisciplinary STEM education. *ZDM*, *51* (6), 869–884. https://doi.org/10.1007/s11858019011005

Marliani, N. (2015). Improving Students' Mathematical Creative Thinking Skills through the Missouri Mathematics Project (MMP) Learning Model. *Formative: Scientific Journal of MIPA Education* , *5* . https://doi.org/10.30998/formatif.v5i1.166

Martín-Páez, T., Aguilera, D., Perales-Palacios, F. J., & Vílchez-González, J. M. (2019). What are we talking about when we talk about STEM education? A review of literature. *Science Education, 103*(4), 799–822.

Nurjanah, Labulan, PM, & Haryaka, U. (2020). Identification Of Students' Mathematics Learning Difficulties In Class Vii Students Of Smp Budi Luhur Samarinda In The Material Of Assistance. *National Seminar On Mathematics, Science, Geography, And Computer* Education, 71–76.

Nurtasari, AR, Jamiah, Y., & Suratman, D. (2017). Student's Misconceptions About Collection Materials In Grade VII of SMP Santa Monika Kubu Raya. *Equatorial Journal of Education and Learning (JPPK)* , *6* (2), 1–10.

Oktadila, N., Yerizon, Musdi, E., & Asmar, A. (2022). Development of Mathematical Learning materials with the Integrated Science Technology Engineering And Mathematics (STEM) Project Based Learning Model in Improving the Mathematical Reasoning Ability of Grade VII Middle School Students. *JEMS (Journal of Mathematics and Science Education)* , *10* (1), 103–110. https://doi.org/10.25273/jems.v10i1.11945

Plomp, T., & Nieveen, N. (2013). *Educational design research. Part A : an introduction* . Slo.

Pratiwi, WNF, & Rita P. Khotimah, S. (2016). *Analysis of Students' Learning Difficulties in Association Materials at SMP Muhammadiyah 10 Surakarta in the 2015/2016 Academic Year* . Eprints.ums.ac.id. http://eprints.ums.ac.id/id/eprint/48132

Priatna, N., Avip, B., & Mulyati Mustika Sari, R. (2022). The Effectiveness of Project Based Learning-STEM and Student Mathematical Problem Solving in Trigonometry

Material. *SJME (Supremum Journal of Mathematics Education)* , *6* (2), 151–161. https://doi.org/10.35706/sjme.v6i2.6588

Putra, HD, Akhdiyat, AM, Setiyani, EP, & Andiarani, M. (2018). Mathematics Creative Thinking Ability of Middle School Students in Cimahi. *KREANO* , *9* (1), 47–53. https://doi.org/http://dx.doi.org/10.15294/kreano.v9i1.1247

S, M., & Xaverius, APF (2020). Discovery and Exploration of the Surrounding Nature (SNE) Approach to Learning the Concept of Classification of Living Things. *Journal of Biology Education* , *3* (1), 44. https://doi.org/10.21043/jobe.v3i1.7131

Sagala, R., Umam, R., & Thahir, A. (2019). The Effectiveness of STEM-Based on Gender Differences: The Impact of Physics Concept Understanding. European Journal of Educational Research, 8(3), 753–761. https://doi.org/10.12973/eu-jer.8.3.753

Şahiner, e., & Koyunlu ünlü, z. (2022). Mühendislik Tasarım Süreci Etkinliklerinin Sınıf Öğretmen Adaylarının STEM Farkındalıkları and Mühendislik Algıları Üzerine Etkisi. *Cumhuriyet International Journal of Education* . https://doi.org/10.30703/cije.971521

Saputro, B. (2017). *Research & Development Management For Thesis And Dissertation Preparation* (1st ed., p. 8). Aswaja Presindo.

Sirajudin, N., Suratno, J., & Pamuti. (2021). Developing creativity through STEM education. *Journal of Physics: Conference Series* , *1806* (1), 012211. https://doi.org/10.1088/1742-6596/1806/1/012211

Soeviatulfitri, & Kashardi. (2020). Students' Mathematical Creative Thinking Ability through the Problem Based Learning (PBL) Model and the Osborn Learning Model in Middle School. *Rafflesia Journal of Mathematics Education* , *5* (3), 35–43. https://doi.org/https://doi.org/10.33369/jpmr.v5i3.11502

Sumarni, W., & Kadarwati, S. (2020). Ethno-stem project-based learning: Its impact to critical and creative thinking skills. *Jurnal Pendidikan IPA Indonesia*, *9*(1), 11-21.

Suripah, S., & Sthephani, A. (2018). Students' ability to think creatively mathematically in solving cube roots of complex equations based on the level of academic ability. *Pythagoras: Journal of Mathematics Education* , *12* (2), 149–160. https://doi.org/10.21831/pg.v12i2.16509

Syahnaz, RAGL (2021). *Analysis of Creative Thinking Ability in View of Learning Styles in Class VII Student Association Materials at SMPN 1 Pakisaji* (pp. 32–45) [Thesis Thesis].

Syamsi, A. (2014). An Innovation in Mathematics Learning Based on Simple Teaching Aids). *Eduma : Mathematics Education Learning and Teaching* , *3* (1), 17–31. https://doi.org/10.24235/eduma.v3i1.4

Syukri, M., Halim, L., & Mohtar, LE (2017). Engineering Design Process: Cultivating Creativity Skills through Development of Science Technical Products. *JOURNAL OF FIZIK MALAYSIA* , *38* (1).

Tulalessy, QD (2018). Environment Based Language Learning As An Effort To Build Ecological Intelligence. *Triton Pendidikan Journal* , *1* (1), 51. https://doi.org/10.30862/jtp.v1i1.795

Yulianti, D., Wiyanto, Rusilowati, A., & Nugroho, SE (2020). Student worksheets based on Science, Technology, Engineering and Mathematics (STEM) to facilitate the development of critical and creative thinking skills. *Journal of Physics: Conference Series* , *1567* , 022068. https://doi.org/10.1088/1742-6596/1567/2/022068

Yunita, Y., Juandi, D., Tamur, M., Adem, AMG, & Pereira, J. (2020). A meta-analysis of the effects of problem-based learning on students' creative thinking in mathematics. *Beta: Journal of Tadris Mathematics, 13* (2), 104–116. https://doi.org/10.20414/betajtm.v13i2.380