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Exploration of Student's Mathematical Connection Ability in PjBL with Ethnomathematics Nuance

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Abstract

The Merdeka Curriculum is one of the government's efforts to recover education after being affected by the Covid-19 pandemic, through project-based learning and Pancasila student profiles. The purpose of this study was to explore students' mathematical connection skills through project based learning (PjBL) with ethnomathematics in the form of painting the motifs of batik or tenun on cartesian diagrams as the implementation of the Merdeka Curriculum. This research was qualitative research with data triangulation. The research data will be obtained through interviews, observations, and project activities carried out by 15 students of class XI IPA 2 at SMAN 11 South Tangerang City. The results showed that the use of weaving motifs in project-based learning can facilitate students' mathematical connection skills, create meaningful and contextual learning as an embodiment of the Merdeka Curriculum to restore teaching and learning activities due to the impact of COVID-19.

1. Introduction

Mathematics is one of the most important subjects that must be learned from an early age. Curriculum 2013 explain that the students are able to improve intellectual abilities, especially high-level of abilities students, form students' ability to solve a problem systematically, obtain the highest score in learning, train students in communicating ideas especially in writing scientific papers, and develop students' character. Based on the learning objectives of mathematics the Ministry of Education and Culture Number 22 of 2006, that students are able to understand mathematical concepts, explain the relationship between concepts and relate one concept to another, so that students are able to solve mathematical problems both understanding problems, compiling models, solving models, and providing appropriate mathematical solutions (Depdiknas, 2006).

To support the success of mathematics learning objectives, there are five standards of mathematical abilities that students must have, including problem solving, reasoning and proof, communication, connections and representation (NCTM, 2000). The National Council of Teachers Mathematics states that of the five ability standards, mathematical connection ability is one of the most important abilities for students to have (NCATE/NCTM 2003:2). Mathematical connection is the ability to recognize, use, and make connections between and among mathematical ideas and in contexts outside mathematics to build mathematical understanding (NCATE/NCTM, 2003: 2).

In reality, the results obtained are not easy to achieve the goal of learning mathematics, or even mastering mathematical skills. Moreover, Indonesia is currently affected by the pandemic caused by Corona Virus Disease (COVID-19). Because of the pandemic, learning must be done online. This is stated in the decision of the Minister of Education and Culture No. 36962/MPK.A/HK/2020 concerning Online Learning and Working at Home to Prevent the Spread of Corona Virus Disease (COVID-19). The existence of the

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Covid-19 pandemic has become a new obstacle in the world of education. Based on the results of preliminary research in the form of interviews and observations, researchers found a significant problem. Students' mathematical abilities are low, especially the ability to understand concepts and the ability of students to link and construct among mathematics concepts. It has an impact on students' achievement in mathematics. In addition, due to the impact of COVID-19, the learning that is carried out is less than optimal and meaningful, because most students only follow or copy what the teacher writes either on the board or shares the learning videos, without really understand the math material. The results of interviews and observations show that students' ability to relate among concepts in mathematics is still weak.

Due the importance of students' mathematical connection ability which is one of the manifestations of national education goals, it is necessary to use learning methods that can improve students' mathematical connection ability in accordance with the indicators of mathematical connections, such as connecting the connections among mathematical ideas, applying mathematics to contexts outside of mathematics, and demonstrating mathematical ideas are interconnected and building to produce a unified whole or connections between mathematics and everyday life (NCATE/NCTM 2003: 4). According to research by Jaijan & Loipha (2012) mathematical connection skills can be improved by student-centered learning rather than teacher-centered learning. This is in accordance with the new policy issued by The Ministry of Education, Culture, Research and Technology Number 56 of 2022 concerning the Restoration of Learning with Merdeka Curriculum. Where the Merdeka Curriculum is a refinement of the Curriculum 2013 through meaningful learning by project-based learning and the Pancasila profile.

Project-based learning is a learning model that focuses on the main concepts and principles of a discipline, which involves students in solving problems and other meaningful tasks, provides opportunities for students to work autonomously in constructing their own learning, and then produces valuable and realistic student work products (Nurfitriyanti, 2016). In addition, the Project Based Learning (PjBL) learning model is an innovative learning model that is able to create a "constructivist" learning environment where in the learning process students build and develop their own knowledge, and educators become facilitators (Stivers & Goodman, 2010). Learning with this method makes it easier for students to understand and relate mathematical concepts and students become active and independent in thinking about analyzing a problem, so that the problem is solved.

To help students stay focused on mathematical concepts or subject matter and achieve learning objectives, teachers can use learning media as a tool. Setyadi & Qohar, (2017) stated that meaningful learning methods can be assisted by the use of a medium as a tool for students to receive information. One of them is visual media, which only involve the sense of sight in conveying information / stimulating student learning (Wahab et al., 2021:15). Such as visual objects that we can find around students and contain cultural values. Such as batik/tenun motifs that students even wear at least once a week as one of the students' uniforms. The use of learning media can be through realistic objects found around students or from cultural activities that are close to students' daily lives.

In mathematics, linking approach between mathematics concepts and cultural elements is called ethnomathematics. Learning with an ethnomathematics approach is considered more meaningful, because mathematical values are very close to human daily life. Freud (Suryawan, 2017; Heuvel and Panhuizen, 1996), states that mathematics must be connected to reality, close to students, and relevant to people's daily lives. Learning with ethnomathematics can be an approach that is applied in the classroom, because Indonesia has a lot of cultural diversity. This cultural diversity is the main support for the ethnomathematics approach in learning mathematics (Choirudin et al., 2020). Like Subekhi & Nindiasari (2021) research which shows the existence of mathematical activities in geometry material in one of the cultural diversities, such as batik from Lebak, Banten Province. The existence of ethnomathematics is an intermediary between mathematics and culture, can simplify students in recognizing, mastering, and understanding mathematical concepts because it is close to community activities. In addition, the use of ethnomathematics can also foster a sense of love for the homeland by recognizing the cultures that exist in Indonesia.

In this research, the Project Based Learning model used ethnomathematics nuances which are found in motifs from Indonesian tenun or batik. Through Project Based Learning mathematics, students can directly analyze the link between cultural elements and mathematical concepts, such as geometric transformations. Students can recognize and connect among mathematical ideas in completing projects, link mathematical ideas with disciplines outside of mathematics, and with real life. As well as the actualization of a Merdeka Curriculum in the form of projects and Pancasila profiles. Learning will be carried out with projects related

to local culture in the form of tenun or batik motifs, where students will analyze and construct the concept of geometry transformation material. Construction drawings on batik or tenun motifs are presented in Figures 1 and 2.

a b

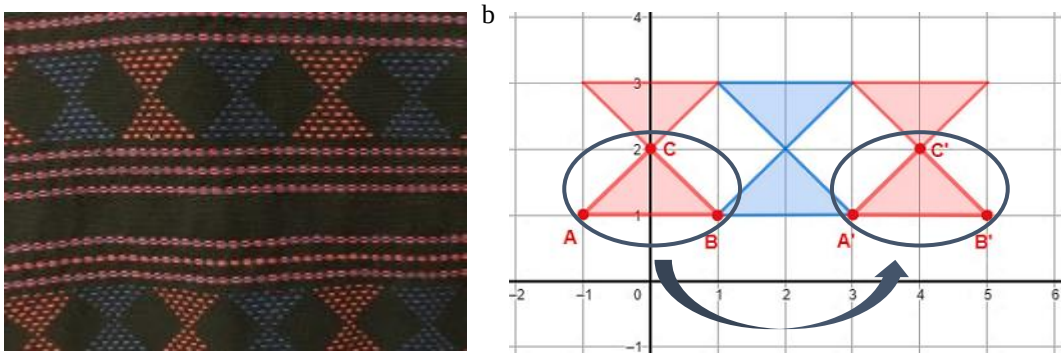


Figure 1. (a) adu mancung motifs from Tenun Baduy; (b) transformation geometric of adu mancung motifs from Tenun Baduy

Indonesia is rich in various tribes and cultures, making Indonesia rich in arts and culture such as tenun or batik. Tenun and batik crafts are traditional textile products that have different characteristics in each tribe, culture, and region. Indeed, tenun or batik is not only a piece of cloth. but also, it is a symbol of a culture that is justly pervasive in social life and contains the spiritual value of its people. In this research, we will focus on the motifs of tenun and batik that will be analyzed and associated with mathematical elements.

The Adu Mancung motif is one type of tenun from Baduy, that if you observe carefully contains elements of geometry, such as form triangles that are arranged into beautiful, meaningful, and philosophical motifs. The triangles are well structured, with opposite angles and congruent, then what kind of mathematical calculations are used to make the triangles can be structured into a motif in Tenun Baduy. The problem can be solved by students if they have mathematical connection skills.

Through Project Based Learning with ethnomathematics, the students will solve mathematical problems related to cultural activities by doing projects. Students carry out activities to make tenun or batik motifs based on student ideas, then construct them into the concept of geometric transformations. Students will plan, observe, apply, communicate the information obtained during the ethnomathematics project. So this research aims to explore students' mathematical connection skills and explore the implementation of the Merdeka Curriculum through project-based learning with ethnomathematics nuances.

2. Method

This research used descriptive qualitative design with data triangulation techniques. Qualitative research aims to get comprehensive data that contains deep-meaning. The deep-meaning is the actual data, which is in the form of a value behind the visible data (Sugiyono, 2014:15). In this research, students will be taught using project-based learning with ethnomathematics nuances to explore students' mathematical connection skills. The subjects in this study were 15 students of class XI IPA-2. The implementation of the research was taken at SMAN 11 South Tangerang by offline.

Data collection techniques are collected by interview, observation, and assessment of student projects in the form of painting tenun or batik motifs on cartesian diagrams which are then constructed into mathematical calculations according to the concept of geometric transformation. Qualitative data will be obtained by triangulation from interviews, observations, and student project results. Qualitative data analysis in this research is reduction, data display, and conclusion drawing. Interview data was collected by conducting direct interviews with mathematics teachers and a random sample of 15 students of class XI IPA 2 at SMAN 11 South Tangerang City. The researcher will rechecked the results of the interview with the teacher through observations to students about the material of geometric transformations. After the researcher gets the data, the researcher gives treatment to the class with project-based learning with ethnomathematics nuances on tenun and batik motifs in order to examine the effects that arise on students' mathematical connection abilities, as an implementation of Merdeka Curriculum. The aid instrument in this research is in the form of a student project sheet. Student projects will be assessed and then determined the

level of student completeness of project-based learning. Aspects of the assessment in this research are based on the stages of the project-based learning and contain indicators of students' mathematical connection skills, so in this project assessment there are five indicators from three aspects of project assessment. They are (1) planning the project completion strategy, (2) connecting among concepts in mathematics, (3) connecting among mathematical concepts with contexts outside of mathematics, (4) connecting among mathematical concepts with real life, (5) project performance. Based on the scoring above, if one indicator has a maximum score of five, then the five indicators have a maximum score of 25 points. The criteria for assessing projects that contain indicators of students' mathematical connections are as below.

Table 1. Criteria of Students Project Assessment

Description	Score
Bad	1-10
Good	11-18
Excellent	19-25

(Amaliah et al., 2018)

3. Result and Discussion

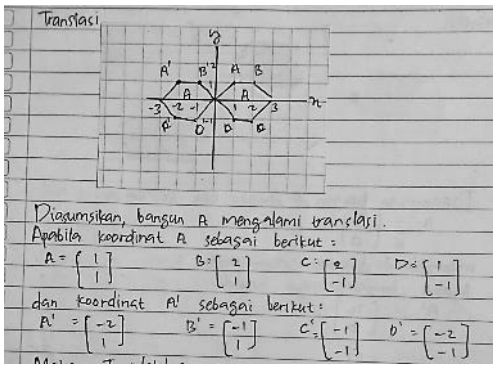
3.1 Result

The results of this research show that project-based learning with ethnomathematics nuances able to facilitate students' mathematical connection ability. Students are able to explore their mathematical connection skills through project activities that provided by researchers. This is shown through the results of student projects, as below.

(1) Indicators of Connection Among Topics in Mathematics

The students are able to connect between the topics of matrix operations, coordinate systems, and trigonometry in geometric transformations.

a



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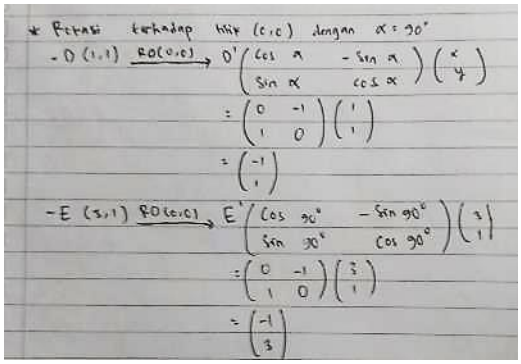

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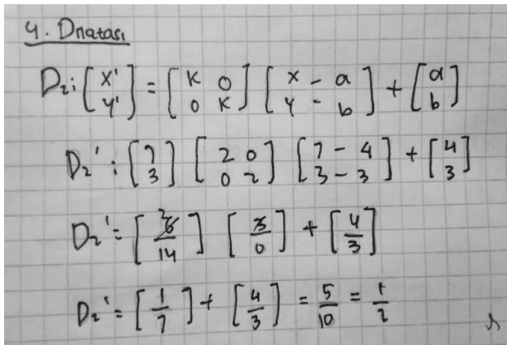

d

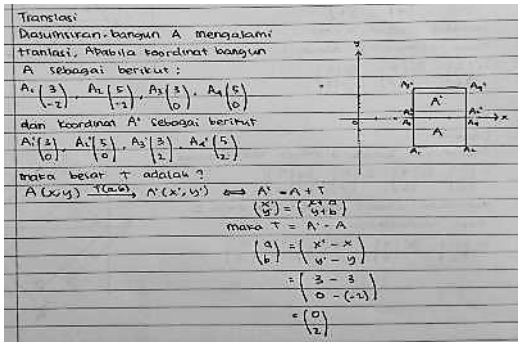

Figure 2. (a) connecting between geometry transformation and cartesian coordinates; (b) connecting between geometry transformation, matrix, and trigonometry; (c) connecting between geometry transformation and matrix operation; (d) connecting between geometry transformation, cartesian coordinates and matrix.

Based on the results of student projects, students are able to link or connect among topics in mathematics. As shown in Figure 2(a) students are able to connect among the topics of coordinate systems

with concepts in geometric transformations. In Figure 2(b) students are able to connect among trigonometric topics with concepts in geometric transformations such as the concept of rotation. In Figure 2(c) and Figure 2(d) students are able to connect among the topics of matrix operations such as addition, subtraction, and multiplication of matrices with concepts in geometric transformations such as reflection, translation, rotation, and dilatation.

(2) Indicators of Connections between Mathematics Topics and Contexts Outside of Mathematics

The students are able to connect among topics in geometry transformation with contexts outside of mathematics.

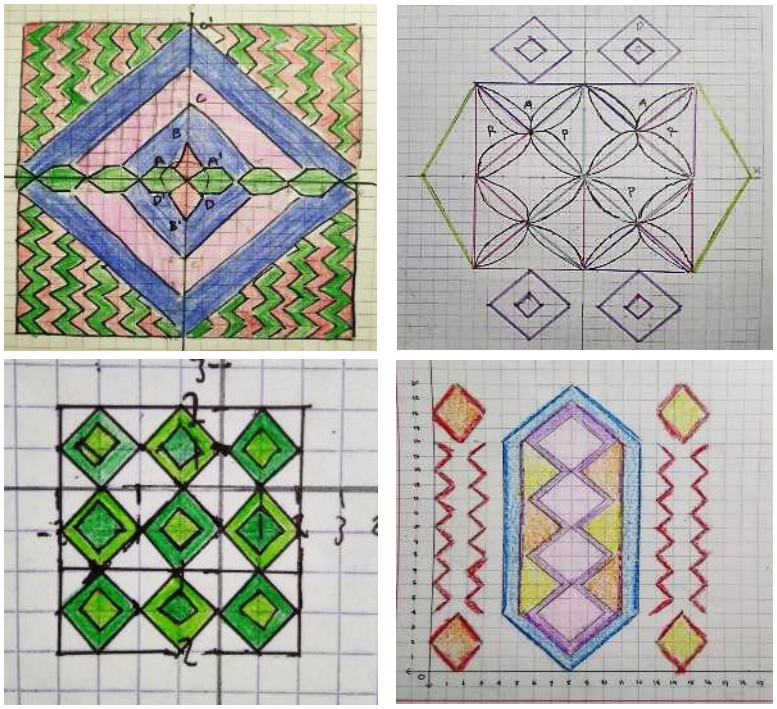

Figure 3. the result of students project, connecting between geometry transformation, cultural, and art.

Based on the results of student projects in the form of painting tenun or batik motifs on the Cartesian diagram, it means indirectly the students are able to link among the topic of geometry transformation with contexts outside of mathematics, such as culture, cultural heritage, and art. especially, the students are able to show the application form of the concept of geometry transformation on weaving and batik motifs. As shown in Figure.3, students apply the mathematical concepts of geometry, points, lines, curves, plane figure or two-dimensional figure, to the concept of geometric transformations as the focus of the material in the research.

(3) Indicators of Connection Between Mathematical Topics and real life

In the connection indicator between the topic of geometry transformation and real life is not seen through contextual questions, instead from project activities that are related to daily activities. Such as batik or tenun, which is carried out by several socio-cultural groups in Indonesia, even as a livelihood.

a b c

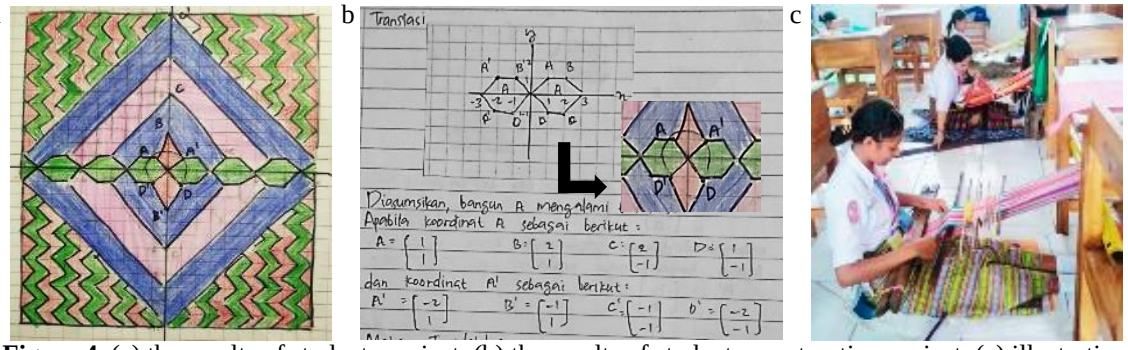

Figure 4. (a) the results of students project; (b) the results of students construction project; (c) illustration of students learning to weave.

Based on the results of student projects in Figure 4, the students are able to directly connect among mathematical concepts with real life. Especially, students are able to apply the concept of geometric transformation to tenun and batik motifs that are carried out by community groups in daily life. Students are able to show mathematical calculations and solutions in the manufacturing or form of tenun and batik motifs that formed in student project activities in accordance with the concept of geometric transformation.

Based on the results of student projects, students are considered to have achieved mastery of mathematical connection ability, as below.

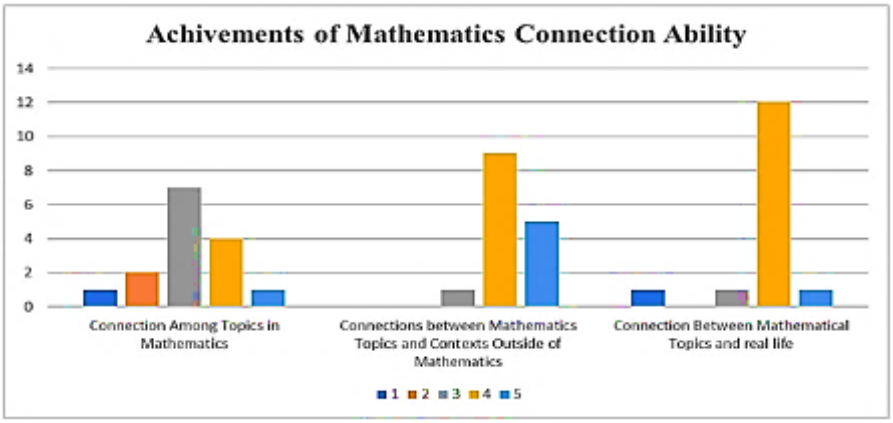

Figure 5. Achievement of Mathematics Connection Ability

The diagram above shows that the indicator of connection ability among mathematical topics student completeness got the highest score of 3 with 7 students out of 15 students. The indicator of connection ability between mathematics and contexts outside mathematics student completeness got the highest score of 4 with 9 out of 15 students. And the indicator of mathematical connections with real life got the highest score of 4 with12 out of 15 students. And based on the assessment criteria, the results of the student project reached excellent criteria with a score of 24.

3.2 Discussion

Based on the results of data analysis, it shows that the application of project-based learning with ethnomathematics nuances, is able to facilitate students' mathematical connection skills on geometric transformation material. Project-based learning that implemented more effective, as explained by Surya *et al*, (2018) that use of project-based learning requires problem solving skills to be applied in completing the project, thus students will get real experience in making projects (Pulungan, 2021).

The project carried out in this learning is linked to ethnomathematics, which is mathematics that is close to cultural elements. Learning with an ethnomathematics approach is considered more effective, because mathematical values are closely related to human life. In order to create meaningful learning in addition to project-based learning, mathematics learning must also closer to real life. It will be easier for students to understand. Freud (Suryawan, 2017; Heuvel and Panhuizen, 1996), stated that mathematics must be connected to reality, close to children, and relevant to people's daily lives. In addition, the selection of mathematics content depends on the situation that is interesting for the students, because motivation and creativity are key components in the teaching and learning process in mathematics (Saparuddin et al, 2019).

Project-based learning also has high potential to increase students' interest in learning mathematics (Gunawan et al, 2017). This is proved by the results of interviews with students during the presentation of project results, students stated that they did not think that mathematics was very close to daily life. According to students, mathematics is only learning to memorize formulas and is complicated because it all contains numbers and seems very difficult. But learning mathematics with batik project is very unique and interesting. Based on their statement, they stated that the batik project activity made students curious and more enthusiastic about completing the project.

Based on the results of ethnomathematics nuanced projects, students achieve the assessment aspects of project-based learning, such as (1) planning project completion strategy, (2) project implementation, and (3) project performance. Students are able to coordinate project completion time according to a predetermined time, able to strategize project completion so that the project is completed properly and gets the maximum process and results. And students are able to evaluate, present, and display their projects well

in front of the class. The completion of students' mathematical connection skills in project-based learning with ethnomathematics nuances is indicated by the achievement of three indicators, namely, (1) connections between topics in mathematics, (2) connections between mathematics topics and context outside of mathematics, and (3) connections between mathematics topics and real life.

Indicators of connection ability among topics in mathematics student completeness obtained the highest score of 3 with 7 students out of 15. Students who had difficulty to show the coordinate location of a point, through batik projects, now students are able to show a geometric transformation object with coordinate points. Using of tenun motifs facilitates students to connect among the concepts of coordinate systems, matrix operations, and trigonometry in the concept of geometric transformations. Matrix material and coordinate systems are the main material in geometric transformations, where geometric transformations are applied material from matrices and the location of objects or shadows is shown in the form of a coordinate system.

The next indicator is the indicator of connection ability between mathematics and contexts outside mathematics. In this indicator, student completeness obtained the highest score of 4 with 9 out of 15 students. Students complete a project in the form of painting tenun or batik motifs with individual creativity. Making these motifs makes students indirectly search, know, understand, and recognize the diversity of cultural elements, especially tenun and batik in Indonesia. In this activities, students indirectly perform art activities that related to the topic of mathematics, such as geometry transformation. The mathematical elements in this project are elements of geometry objects, both plane figure or two dimension figure, spaces, curves, lines, points, to the concept of geometry transformation. Can be seen in Figure.8, the formation of motifs such as 4 flower petals composed of a certain curve, which we can construct into the concept of geometric transformation. As the curve can be reflected to a mirroring center, then rotated at a center of rotation to create a beautiful motif. So through this project, it indirectly facilitates students' ability to connect between math topics and contexts outside mathematics such as art.

The next indicator is the indicator of mathematical connection with real life. In this indicator, the highest score is 4 with 12 out of 15 students. To create the meaningful learning is not only about mathematical solutions but also able to link between mathematical concepts on the topic of geometric transformations with everyday life. Such as the concept of geometric transformations contained in batik and tenun motifs, students link the concept of geometric transformations in the manufacture of batik or tenun motifs to becomes a beautiful motifs. Then students construct the motif into mathematical calculations, like the layout using the cartesian coordinate system, the displacement with the concept of translation, the mirroring to the center of the mirror, rotation with the center of rotation which also uses the concept of trigonometry, as well as dilatation so that large and small objects or shadows of objects are formed.

Based on the analysis of student project results on project-based learning, it can be the implementation of Merdeka Curriculum. Nadiem Makarim as the Minister of Education explained that Merdeka Curriculum is a curriculum that created by the government as an option curriculum and an improvement from Curriculum 2013. The Merdeka Curriculum is flexible learning or also called 'Merdeka Belajar', which is practiced with project-based learning and the Pancasila student profile. The use of project-based learning aims to develop students' soft skills and character in accordance with the Pancasila student profile. Through the project of strengthening the Pancasila profile, students have the opportunity to explore knowledge, skills, and strengthen the six dimensions of Pancasila students, such as; (1) faith, devotion to God Almighty, and have noble character, (2) global diversity, (3) mutual cooperation, (4) creativity, (5) critical reasoning, (6) independence. As well as being able to create meaningful learning and not only focused on the results, but also on the learning process through projects and Pancasila student profiles.

In this research, the implementation of Merdeka Curriculum by realizing project-based learning and prioritizing the Pancasila student profile. In the aims of learning geometry transformation in Merdeka Curriculum, was written that geometry transformation material is an application of matrix material to solve an object that undergoes a geometric transformation that changes the position and shape, both with graphic and algebraic images. Meanwhile, in the Pancasila profile, students are able to reason critically in finding shadows of objects, points, lines, and curves that undergo geometric transformations, and creatively in solving with shadow images of objects. By doing project activities in this research, the learning goals of geometry transformation are realized, that students are able to solve algebraically and show an object that undergoes geometry transformation by applying the concept of matrix. As well as realizing the Pancasila profile through students complete projects creatively, original, and critically in finding shadows of objects,

points, lines, and curves that undergo geometric transformations on tenun or batik motifs that students create.

The results of students' projects also show the application of the use of cultural values in mathematics learning. Miller (2022) states that how importance of a teacher to find the authentic connections and possibilities between mathematics and contexts outside mathematics that can activate students' mathematical skills. So that the existence of ethnomathematics becomes a link between mathematics and cultural values that can trigger students' mathematical skills. By using of tenun or batik motifs as visual media in mathematics learning, which is then packaged with project-based learning, can create meaningful and contextualized mathematics learning (Kinasih, 2019: 6). In addition, Using ethnomathematics as a means of preserving and inheriting cultural values that have begun to disappear, and as a meaningful learning innovation that can trigger and facilitate students' mathematical abilities. This is accordance with the Merdeka Curriculum based on meaningful learning through projects and Pancasila student profiles.

4. Conclusion

Based on the data analysis above, it can be concluded that using of tenun or batik motifs in project-based learning (PjBL) with ethnomathematics nuances at SMAN 11 South Tangerang City can facilitate students' mathematical connection ability in geometry transformation material. This is shown by the ability of students to explore the concept of geometric transformation in project-based learning by using tenun or batik motifs on students' mathematical connection abilities. Through project activities students are able to show the location of objects and shadows of geometric transformations contained in tenun or batik motifs, then students show the link among the concepts of geometric transformations with other concepts in mathematics, contexts outside mathematics, and real life. Project-based learning with ethnomathematics nuances can create active learning, creative, interesting, unique, meaningful, and contextual learning through ethnomathematics project. Accordance with the Merdeka Curriculum, project based learning with ethnomathematics nuances by using tenun or batik motifs can realize the implementation of the Merdeka Curriculum as a resolution of teaching and learning activities due to the impact of Covid-19, and can be an effort that can create the effective learning innovations.

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