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Hypothetical Learning Trajectory in Scientific Approach on Material Direct Proportion: Context of Rice Farmers' Activities Pandanwangi Cianjur

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ABSTRACT

Rice farmer activities can be used as a context for understanding mathematical concepts. There are many studies on Hypothetical Learning Trajectory (HLT) on direct proportion material with a cultural context background. However, there is no research that focuses on using the context of Pandanwangi rice farmers to facilitate students in understanding material in direct proportion.This study aims to design Hypothetical Learning Trajectory (HLT) in Scientific Approach on Material Direct Proportion in the Context of Rice Farmers' Activities in Pandanwangi Cianjur, who are familiar with student culture in Cianjur. This research is part of design research. The research design consisted of HLT, namely learning objectives, learning activities, and student learning hypotheses. The result of the research is the set of HLT in the context of Pandanwangi Rice Farmer Activities, which includes learning objectives, learning activities, and the assumptions of each activity. This HLT can be a promising solution to overcome students' difficulties in understanding the concept of direct proportion and values in a cultural context to improve students' character.

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A. INTRODUCTION

Mathematics is often taught in schools as a culture-free subject that has no relevance to everyday life (Rosa & Orey, 2017). This gives a negative impression on students' attitudes towards mathematics. Most students believe that mathematics and culture are unrelated (Pathuddin et al., 2021). Humans' ideas, strategies, and ways for adjusting to their surroundings gave rise to mathematics (Prahmana et al., 2021). We refer to mathematics as a culture in which humans evolve throughout life, unlike mathematics, which is influenced by historical, environmental, social, and geographic elements (D'Ambrosio, 2016; Risdiyanti & Indra Prahmana, 2020; Utami et al., 2020). Mathematics is related to everyday people's activities in certain cultural groups, such as counting, measuring, designing buildings, and others. Guidelines from the NCTM (1991) underline how crucial it is to make a connection between students' personal and cultural lives and mathematics.

Certain social cultures that contain mathematical concepts are called ethnomathematics. Ubiratan D'Ambrosio coined the phrase "ethnomathematics," which is used in educational (D'Ambrosio, 1985). As a pedagogical innovation in mathematics education, ethnomathematics seeks to inspire students, excite them, and boost their creativity in the subject. Ethnomathematics is a culture-based mathematics learning approach. According to (D'Ambrosio, 2016) and (Rosa & Orey, 2016) ethnomathematics is a way for examining and fusing concepts, approaches, and strategies used and developed by sociocultural individuals from other cultures. Ethnomathematics views the importance of considering the cultural aspects of students to bring them closer to learning mathematical concepts used in everyday practice (Gavarrete & Albanese, 2021).

This illustrates how mathematical concepts are created dependent on how they are taught in schools. In order to help students develop their ability to reason critically and democratically and to be tolerant of different ideas and ideas during the teaching and learning process, ethnomathematics attempts to reconstruct mathematics so that it is rooted in various cultures and accommodates other ideas (D'Ambrosio, 2016; Risdiyanti & Indra Prahmana, 2020). Therefore, ethnomathematics can be employed as an educational innovation in mathematics education with the goal of inspiring students to love mathematics, inspire them, and develop their mathematical creativity. Ethnomathematics facilitates the easier exchange of scientific ideas between youngsters, lessening the impact of cultural barriers, by leveraging individual and group cultural experiences and practices (D'Ambrosio, 1985). Based on several theories suggest that the role of ethnomathematics matches the cultural context with the content of mathematics in schools.

Because studying in the local culture will give students more meaningful learning as an example of the learning process itself, which is frequently met by students in everyday life in their culture, ethnomathematics is a good application for a scientific approach (Lena et al., 2019). The scientific approach is a learning process that allows students to develop an idea by observing, asking questions, reasoning, experimenting, and conveying the results discovered (Ifanda et al., 2017; In'am & Hajar, 2017; Yusmaniar et al., 2022). Students can learn how to find information from their experiences using this method as they expand their scientific knowledge, abilities, and attitudes (Wijayanti & Munandar, 2017). In other words, scientific learning can encourage students to gather information from diverse sources through observation in order to have a deeper knowledge (Hirzi & Gazali, 2020). Through this strategy, they are encouraged to use their environment as a learning tool so that learning can occur outside of the classroom as well as through direct observation of the subject matter being taught (Firman et al., 2018).

This scientific method to mathematics learning gives chances to leverage local cultural settings to improve students' numeracy by rediscovering mathematics that is anchored in the culture around them and the benefits of the mathematical principles it discovers. Pandanwangi rice farmers' activity is one of the cultures in Java, particularly in West Java's Cianjur Regency, that contains mathematical qualities. The majority of the people of Cianjur work as farmers, and this becomes the context of their closeness to previous knowledge of students. The results of cultural exploration research on farmers include tobacco farmer activities(Suwarno et al., 2020), coffee farmer activities (Sunardi et al., 2019), and village farming communities (Suprayo et al., 2019) but not yet in the context of pandanwangi farmers. This Pandanwangi rice farmer's activity contains mathematical values, especially the concept of direct proportion.

This can be utilized as a jumping-off point for learning and rediscovering mathematical principles in direct proportion materials. Furthermore, the activities of Pandanwangi rice farmers are a culture that includes the pillars of Cianjur culture (Carel et al., 2018; Indriyani, 2021; Indriyani et al., 2022; Sarah & Rani, 2020). There should be internal and external assistance in establishing positive character because the educational environment alone is insufficient to construct student character(Tyaningsih et al., 2020).

Therefore, in order to facilitate students' numeracy abilities in direct proportion to resources, we require a learning trajectory based on a scientific approach. The learning trajectory of (Clements & English, 2004) describes students' thinking during the learning process in the form of conjectures and hypotheses from a variety of learning designs to encourage students' thinking development so that the goals of learning mathematics can be achieved as expected. The term learning trajectory (LT) was originally used to describe the learning process when students experience the learning process from the beginning to the achievement of learning objectives by (Simon, 2020) in the context of mathematics. This learning trajectory takes the shape of learning steps that start by providing the actual context, continue by using that context to rediscover mathematical concepts, and end with students being able to comprehend the concept in its standard form.

There is research related to Hypothetical Learning Trajectory (HLT) on Limit and Derivative material (Khairudin, 2022), Function (Mardiah et al., 2021; Simon et al., 2018; Yulia et al., 2020)with a realistic mathematics approach, and cultural approach context lines and angles material (Kusumaningsih, 2022). However, there is no research that focuses on using the context of Pandanwangi rice farmers to make it easier for students to understand direct proportion material. These findings will also assist students in comprehending the connection between mathematics, culture, and their everyday lives, familiarize them with the use of mathematics, and inspire them to think intellectually and meaningfully. This curriculum can be a different approach to enhancing students' numeracy ability in direct proportion lessons while upholding Indonesian culture.

B. METHODS

This research is part of design research a type of qualitative. The purpose of the research is to provide teaching and learning interventions to address issues with education (Gravemeijer & Cobb, 2020; Weskamp, 2019). Learning objectives, learning activities, and student learning hypotheses make up the three parts of HLT. These sections are organized in a way that should be easy to understand and illustrates the solutions to the stated research problems. Design research can respond to the formulation of the issue and accomplish research goals (Prahmana et al., 2021; Weskamp, 2019). Researchers can examine how students learn using this technique. Knowing how much the activities can aid students in grasping the direct proportion information based on learning obstacle student. The subjects in this study were VII students in Junior High School in Boarding School Cianjur.

According to student learning obsacale, researchers in this study created the alleged learning trajectory within the context of the Pandanwangi Rice Farmer Activities. Students' existing cultural knowledge is examined in order to create a mathematical abstraction process that can be applied to the actual world environment that surrounds them. In order to predict the answers provided by the pupils, the researcher sets the learning steps in addition to a conjecture or suspicion of their response and the purported response that the teacher must provide.

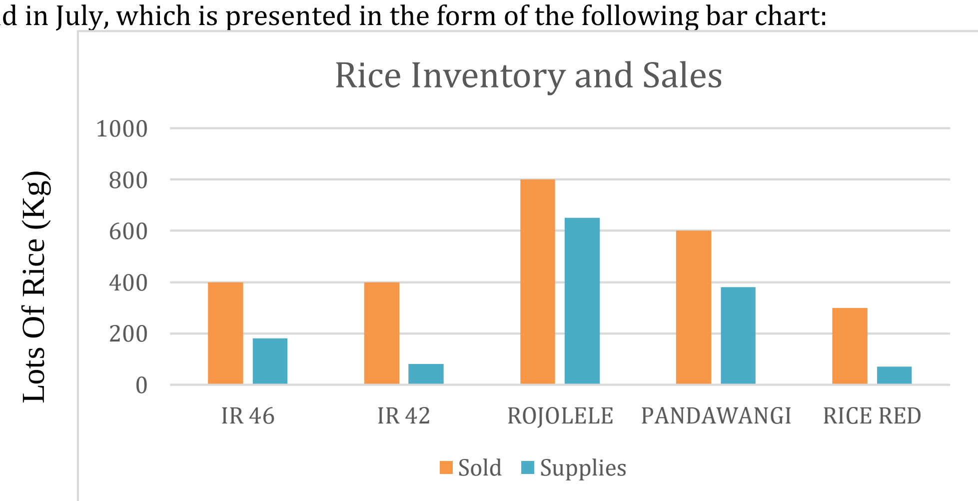
This study represents the preliminary design research phase of the design research process. Researchers create learning activities through library research during the initial design stage. Researchers gathered data from the literature about students' challenges with comparative learning and what activities could help students comprehend comparisons. The stages are formulated beforehand in the form of said learning steps and the purported reactions of students and teachers, known as the Hypothetical Learning Trajectory, before the learning trajectory becomes a local learning theory.

C. RESULT AND DISCUSSION

The initial stage in building a Hypothetical Learning Trajectory (HLT) utilizing the Cianjur cultural context is where students build this foundational knowledge so that students may easily transfer new knowledge about mathematics. HLT is developed for learning, beginning with a review of the literature to identify learning impediments. After that, the researcher made observations at one of the junior high school boarding schools in Cianjur regarding student learning barriers by interviewing one of the mathematics teachers about the implementation of learning and teaching materials used in learning mathematics. The teacher admits that the implementation of learning is often done with lectures providing examples of questions and exercises. The context given to teaching materials is limited to source books and the internet if needed. The math teacher admitted that he never gave teaching materials in a cultural context, let alone the Cianjur culture. Based on the identification of the teacher, the researcher continued on student learning barriers when given one of the numeracy questions sourced from https://pusmenjar.kemdikbud.go.id/ as shown in Figure 1.

RICE TRADERS

A rice shop owner will buy rice to stockpile the following month. Rice sales for August are estimated to be the same as in July. Before buying rice, the shop owner keeps a record of the stock of rice and rice sold in July, which is presented in the form of the following bar chart:



Based on the amount of rice sold, the simplest comparison between IR 46 and Pandanwangi rice is...

Figure 1. Numeracy Problem

In the results of student work on one of the numeracy questions in Figure 1, only one student was able to answer the numeracy question with the concept of the correct direct proportion with student work shown in Figure 2, but the results of the answers did not simplify the simplest proportion according to the order of the question from the proportion of rice sales, as shown in Figure 2.

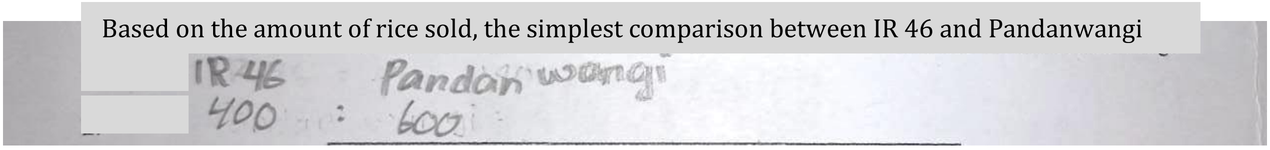


Figure 2. The Results of the Student's Numeracy Answers are Correct

Meanwhile, the other students were almost entirely incorrect in their answers to the numeracy questions. As shown in Figure 3, students are less precise in determining answers from literacy results and understanding concepts from student proportions that are lacking, as shown in Figure 3.

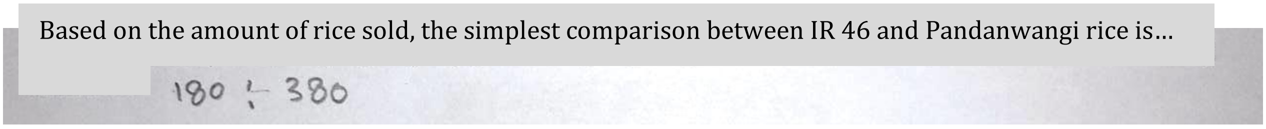


Figure 3. The results of the student's numeracy answer are wrong

The results of the literature review and reviewing the student's abilities are the basis for designing the HLT, which contains a series of learning processes, namely activities, learning objectives, and students' assumptions. The first step in developing an HLT (Hypothetical Learning Trajectory) is a learning activity, and the context used indirect proportion materials to learning will become a local instruction theory that is in accordance with the needs and characteristics of students, so that they can overcome learning barriers and grow their numeracy ability in the learning process that has been designed, as shown in Figure 4.

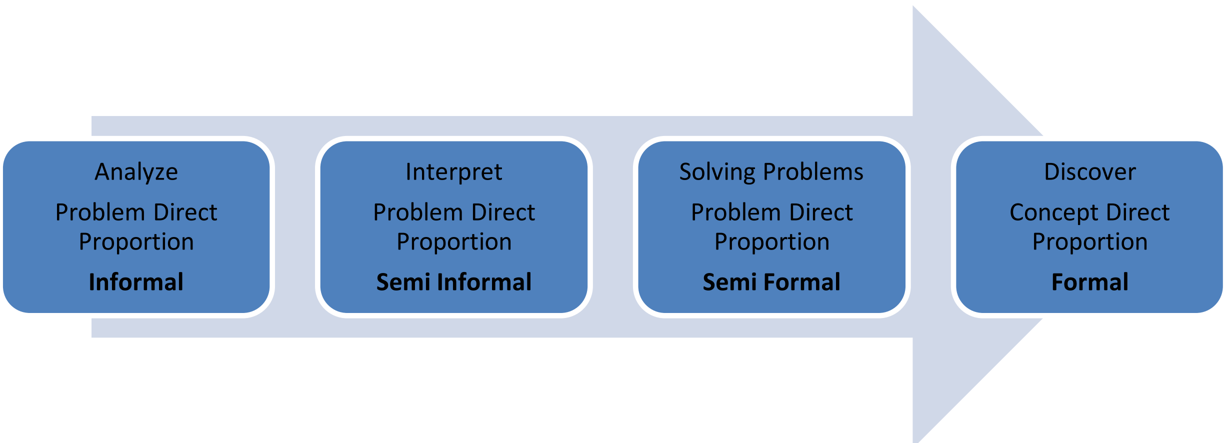


Figure 4. Student Learning Flow in HLT

Several activities were created based on the premise of students' learning trajectories and thought processes. A scientific approach is used in this set of learning activities. The purpose of this research is to examine direct proportion worth by using data tables, graphs, and equations to show one or more basic principles of worth comparison in cultural activities. Depicts the link between student learning paths, learning activities, and concepts. The following describes the relationship between student learning pathways, learning activities, and concepts as shown in Table 1.

Table 1. The Relationship Between Student Learning, Learning Activities, and Concepts

Students' Learning Trajectory Learning	Trajectory Learning Activities	Concept Direct Proportion
Activities in informal	Activity 1 **observes** (**literacy**) Understanding the Culture of Pandanwangi Rice Farmers' activities on the e-worksheet given on the observation sheet. Activity 2 **asks** the problem in the activities of Pandanwangi rice farmers in analyzing fertilizer needs according to the area of rice fields presented in the table.	Understanding, literacy, and basic concepts of propotion such as units of quantity and units of length from the information presented.
Linking Activities	Activities 2 and 3, **reasoning** by interpreting the problem by connecting the information that has been obtained. Activity 4 **tries** to solve it in a simple context.	Determine the unit length conversion. Determine the unit conversion of weight. Find the proportion presented in the table.
Activities in formal	Activity 5 **communicates** the findings of the concepts found.	Finding the Value direct proportion Formula

The set of learning activities as listed in the Hypothetical Learning Trajectory (HLT) in Table 1 consists of scientific activities. The details can be explained in Table 2.

Table 2. Alleged Activities

Activity	Predictions Of Student Responses	Teacher's Responses
The teacher asks the students about their knowledge and experience of the activities of Pandanwangi rice farmers.	Knowing and/or having experience with Pandanwangi rice farmer activities	The teacher asks students to share their knowledge and experiences about the activities of Pandanwangi rice farmers.
	Do not know and/or have no experience with Pandanwangi rice farmer activities.	The teacher talks about the activities of Pandanwangi rice farmers, then asks students to read information about wayang and Pandanwangi rice farmers' activities in the e-worksheet.
Students write important words based on the observations of Pandanwangi rice farmers in the hope of preserving	Write down all the important words on Pandanwangi Rice Farmer's information.	The teacher gives a verbal appreciation of the students' work.
	Write some important words on the Pandanwangi rice farmer's information.	The teacher guides the students to be able to write down all the important words on the Pandanwangi Rice Farmer's information.
Students observe and understand by asking questions on the e-	Students ask how to determine the amount of fertilizer in the area of pandanwangi rice	The teacher asks students to study what is known in the e-worksheet.

worksheet of farmers' activities in determining the proportion of the amount of fertilizer in the area of rice fields with the information presented in the table.	farmers with the information presented in the table. Students don't ask	The teacher guides students to identify what is known and asks about the information presented in the table on the e-worksheet.
Reasoning by interpreting the problem by relating the information that has been obtained to the activity of determining the amount of fertilizer, to the activity of farmers in determining the seed	With the information presented in the table, students one can determine the amount of seeds in the area of rice fields. Students have not been able to determine the amount of seeds in the area of rice fields with the information presented in the table.	The teacher gives a verbal appreciation of the students' work. The teacher guides students to be able to determine the number of seeds in the area of rice fields with the information in the table.
Students try to solve the context given in the table with the application and learning that students have.	Determine crop yields in rice fields, and students can predict the truth of the information presented. Students have not been able to determine the harvest, and students cannot predict the truth of the information presented.	The teacher gives a verbal appreciation of the students' work. The teacher guides students to be able to determine crop yields and students can predict the truth of the information presented.
Students communicate the findings of concepts found from problem activities that students have done in a simple context so that it makes it easier for students to problems direct proportion using formulas.	Find the definition of a direct proportion and a method of solving the concept of a direct proportion through the formula. Couldn't find the definition of direct proportion and solution method.	The teacher gives a verbal appreciation of the students' work. The teacher guides students to be able to find a solution method using the direct proportion formula from the previous activity.

This is worth comparison learning design uses an ethnomathematical context, namely Pandawangi Rice Farmer Activities and a scientific approach. The Pandawangi Rice Farmer Activities environment was selected in the design of this study because it is near to Cianjur culture, namely student culture, and also to students' daily lives (D'Ambrosio, 2016; Risdiyanti & Indra Prahmana, 2020). Furthermore, farming is the primary source of income for the majority of Cianjur residents.

Observing the issues with mathematics education, where the subject is frequently viewed as a terrifying specter and many students struggle to grasp mathematical ideas because they are typically taught a lot of calculations and practical formulas in school without receiving a thorough explanation of the idea of comparison and how it is used in daily life. In contrast, as it is a human activity, mathematics must be connected to culture and everyday life (Freudenthal, 2006).

According to (Ifanda et al., 2017; In'am & Hajar, 2017; Yusmaniar et al., 2022) the scientific approach is a learning process that is intended to help students build concepts through a series of activities, including observation, questioning, reasoning, attempting, and sharing the findings. Students can learn how to find information from their experiences using this method as they expand their scientific knowledge, abilities, and attitudes(Wijayanti & Munandar, 2017). In other words, scientific learning can encourage students to gather information from diverse sources through observation in order to have a deeper knowledge (Hirzi & Gazali, 2020). Through this method, they are encouraged to explore their surroundings as a learning medium so that learning can occur outside of the classroom as well as through direct observation of the material being taught, as the essence of the scientific approach is learning by applying the concept of scientific research to empirical, active, creative, and effective learning (Firman et al., 2018).

The activity begins by giving context in an informal manner by witnessing the activities of Pandawangi Rice Farmers and then identifying the keywords discovered by asking questions. This action continues to make use of the concrete form of the setting. In addition to introducing the context, student activities were asked to determine the amount of fertilizer in the area of Pandanwangi rice farmers' fields with the information in the table. The students analyze and interpret the amount of fertilizer in the farmers' rice fields by observing the change in the area of the rice field. The value of the amount of fertilizer also increases in the table presented. Finally, the formal knowledge activity that defines the ratio of the change in area value to the fertilizer requirement can be written down formally. In the next activity, students are presented with reasoning activities with problem solving presentations. Students are asked to try to solve the problem according to the concept found previously in the case of the activity of one farmer in determining the number of seeds. Then in the next activity, students can practice solving mathematical problems in other Pandanwangi farmer activities, namely in determining the yield of several farmers using the previous proportion concept. The last activity of students is communicating the findings of the concept found from the problem activity that students have worked on in a method or formula with a simple context so that it makes it easier for students to recalculate in calculating direct proportion.

The learning trajectory generated in this study can be considered as an alternative way or frame of reference for teachers to design a series of learning activities through a cultural context that is close to students. This is in line with the research of (Nursyahidah et al., 2021) that using the cultural context of the historic Lawang Sewu building can help students improve their understanding of mathematical concepts. Learning trajectories can support the development of students' conceptual understanding in learning mathematics (Wijaya et al., 2021).

Understanding students' concepts in the material, especially direct proportion material, is an alternative to overcoming student learning barriers by designing learning trajectories. With the learning trajectory, learning about ratios and proportions becomes more meaningful for students (Muttaqin et al., 2017). The use of problems related to student life makes learning more meaningful (Made Arnawa & Nasuha Ismail, 2020). The results of a retrospective analysis showed that the learning trajectory in the context of Musi tourism as a learning model can help students' understanding of learning proportions (Nursa et al., 2020).

Students who are unable to acquire formal mathematics should be made to feel welcome, because they have the right to experience mathematics at a level that they can grasp and apply in everyday life (Shanty et al., 2011). In this learning trajectory, using the cultural context of learning is more meaningful so that it can be easily accepted by students. In addition, students are taught to be able to preserve the values contained therein through learning mathematics, so that it can help students improve their basic skills in numeracy and develop their character in existing cultural values. Learning trajectories with contexts close to students' lives can hone students' thinking power, focus, meaning, and fun and develop good character (Muslimin et al., 2020).

D. CONCLUSION AND SUGGESTIONS

The concept of direct proportion can be understood using local settings such as culture. This study was successful in constructing a learning trajectory in the setting of Pandawangi rice farmer activities using a scientific method. The learning trajectory consists of several activities that are adapted to a scientific approach, namely observing the activities of Pandawangi rice farmers, then identifying keywords found through asking questions, trying to solve mathematical problems that arise in Pandawangi rice farmers' activities, starting with the process of understanding the results of analyzing and interpreting the amount of fertilizer and area of rice fields in the proportion concept presented, applying context to mathematical problems in determining the number of seeds, and students can reason with the problems of farmers' activities in harvesting rice until students communicate the concept findings found from problem activities that students have worked on in methods or formulas with simple contexts, making it easier for students to recalculating direct proportion. Through the learning trajectory, students can preserve the values contained in the cultural context so that they can help students improve their basic numeracy ability and develop character.

Suggestions for further research are to continue research to the implementation stage to see the quality of the learning trajectory. Hopefully, this research will be valuable and serve as a reference point for future research or as a foundation for carrying out learning trajectory on direct proportion materials in the context of others.

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