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# MATHEMATICS IN CONTEXT: A LEARNING DESIGN FOR TEACHING NUMBER PATTERN IN JUNIOR HIGH SCHOOL

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**Abstract**

This study aims to create an effective learning design for teaching number pattern concepts to 8th grade students using the Realistic Mathematics Education (RME) approach, while incorporating the context of Shio Tradition in Chinese Culture. The research employs a design research methodology consisting of three distinct stages: preliminary design, design experiment, and retrospective analysis. In the preliminary design stage, researchers analyze the current curriculum, student needs, and RME principles to develop initial instructional materials and strategies. These materials uniquely integrate the cyclical nature of of Shio Tradition in Chinese Culture as a culturally relevant context for exploring number patterns. The design experiment stage involves implementing these materials in real classroom settings, collecting data through observations, student work samples, and teacher feedback. Finally, the retrospective analysis stage evaluates the effectiveness of the learning design, identifying strengths, weaknesses, and areas for improvement. Throughout all stages, the study focuses on incorporating key RME principles, including the use of realistic contexts, student-constructed models, and interactive instruction. Throughout all stages, the study focuses on incorporating key RME principles, including the use of realistic contexts, student-constructed models, and interactive instruction. The resulting learning design is expected to enhance students' understanding of number patterns, improve their problem-solving skills, and increase their engagement with mathematics while also promoting cultural awareness. This research contributes to the growing body of knowledge on effective, culturally responsive mathematics instruction and provides a systematic approach to developing and refining RME-based learning designs for middle school mathematics education.

**Keywords**: learning design, realistic mathematics education, ethnomathematics, number pattern

**Abstrak**

Penelitian ini bertujuan untuk menciptakan desain pembelajaran yang efektif untuk mengajarkan konsep pola bilangan kepada siswa kelas 8 menggunakan pendekatan Realistic Mathematics Education (RME), sekaligus menggabungkan konteks Tradisi Shio dalam Budaya Tionghoa. Penelitian ini menggunakan metodologi penelitian desain yang terdiri dari tiga tahap berbeda: desain awal, eksperimen desain, dan analisis retrospektif. Pada tahap desain awal, peneliti menganalisis kurikulum terkini, kebutuhan siswa, dan prinsip-prinsip RME untuk mengembangkan materi dan strategi pengajaran awal. Materi-materi ini secara unik memadukan sifat siklus Tradisi Shio dalam Budaya Tionghoa sebagai konteks yang relevan secara budaya untuk mengeksplorasi pola bilangan. Tahap eksperimen desain melibatkan penerapan materi-materi ini dalam lingkungan kelas nyata, pengumpulan data melalui observasi, contoh pekerjaan siswa, dan umpan balik guru. Terakhir, tahap analisis retrospektif mengevaluasi efektivitas desain pembelajaran, mengidentifikasi kekuatan, kelemahan, dan area yang perlu ditingkatkan. Di seluruh tahap, penelitian ini berfokus pada penggabungan prinsip-prinsip RME utama, termasuk penggunaan konteks yang realistis, model yang dibangun siswa, dan instruksi interaktif. Sepanjang semua tahapan, penelitian ini berfokus pada penggabungan prinsip-prinsip utama RME, termasuk penggunaan konteks yang realistis, model yang dibuat siswa, dan instruksi interaktif. Desain pembelajaran yang dihasilkan diharapkan dapat meningkatkan pemahaman siswa tentang pola bilangan, meningkatkan keterampilan memecahkan masalah, dan meningkatkan keterlibatan mereka dengan matematika sekaligus meningkatkan kesadaran budaya. Penelitian ini berkontribusi pada pengembangan pengetahuan tentang instruksi matematika yang efektif dan responsif secara budaya serta memberikan

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pendekatan sistematis untuk mengembangkan dan menyempurnakan desain pembelajaran berbasis RME untuk pendidikan matematika sekolah menengah.

**Kata kunci:** desain pembelajaran, pembelajaran matematika realistik, etnomatematika, pola bilangan

## INTRODUCTION

Patterns have emerged as a significant subject matter within the realm of mathematics. Understanding the patterns and structures plays a crucial role in the initial stages of mathematical learning (Mulligan & Mitchelmore, 2009). The acquisition of knowledge regarding patterns can significantly facilitate the cognitive development of students, particularly in the realm of inductive reasoning (Sari, 2018; NCTM, 2000). Recognizing number patterns is a vital problem-solving skill. Identifying number patterns constitutes an essential skill for problem-solving. The challenges encountered by the students primarily revolved around comprehending the complexities, discerning the underlying patterns, and formulating broad generalizations (Fauzan & Diana, 2019). Comprehending numerical patterns is imperative to enable students of all ages to accurately ascertain and comprehend diverse patterns and functional connections. Moreover, awareness regarding numerical patterns grants individuals the ability to employ models and patterns in order to scrutinize alterations in both tangible and theoretical settings. Based on Mulligan, Mitchelmore, Outhred, & Russell (1997), there are many indications that understanding pattern and structure is essential in early mathematics learning. For example, one of our earlier studies examined the structural characteristics of the representations of various numerical situations made by students from Grades 2-5. The students encountered challenges when attempting to comprehend number patterns due to a lack of comprehensive instruction. The educational approach primarily emphasized the identification of formulas.

Pattern tasks have the potential to assist students in the development of algebraic reasoning. Additionally, they can serve as a valuable instrument in the establishment of classroom norms, particularly at the commencement of the school year. Two primary categories of patterns exist within the field of mathematics, specifically, number patterns and shape patterns (Fauzan & Diana, 2019). Both aforementioned patterns can be observed within the mathematics curriculum administered in educational institutions. Notably, in the context of the recent Indonesian curriculum aimed at junior high school students, the ability to employ number patterns to make predictions, establish generalizations, and resolve mathematical problems has been deemed a paramount objective for students to attain. Although number patterns are commonly observed in our everyday lives and have become an essential component of the mathematics curriculum, various research studies have indicated that many students encounter challenges when learning about number patterns (Stacey, 1989; Chazab, 1993; Sasman, *et* al, 1999; Hoyles & Kuchemann, 2002). The difficulties experienced by these students primarily revolve around comprehending the problems, identifying the patterns, and formulating generalizations (Bieda, Ji X, Drwencke & Picard, 2014).

In the contemporary Indonesian educational landscape, a notable disconnection exists between aspirations and reality. This discrepancy is attributed to deficiencies in evaluation standards, as well as shortcomings in the effectiveness and efficiency of the learning process (Meitrilova & Putri, 2020; Munirah, 2015). Beyond these factors, the suboptimal progress of education in Indonesia is further compounded by inadequacies in facilities, the overall quality and well-being of educators, student achievements, the financial burdens associated with higher education, and elevated unemployment rates (Suroto, 2014). A viable remedy to these educational challenges entails collaborative efforts from various stakeholders, including parents, communities, and schools. Teachers play a pivotal role among these stakeholders, being directly involved with students. Teachers must exhibit creativity in selecting appropriate methods and learning tools that cater to the diverse needs of students.

The use of context in the field of mathematics education enables the mathematical concept to attain relevance. Furthermore, the integration of context into the process of learning mathematics can aid students in establishing clear connections between various contexts and mathematical concepts, thereby contributing to the enhancement of their mathematical reasoning abilities (Nursyahidah, Albab & Rubowo, 2023; Susanta et al., 2022; Widjaja, 2013). The mathematical context is identical to Realistic Mathematics Education (RME) learning. The principle of RME is that activities utilize the context around students' lives to progress to the most abstract level. In the philosophical context of RME, in mathematics must be connected to the real world and must be seen as an activity and construction of human culture (Smith & Morgan, 2016; Richardo et al., 2023). According to Meryansumayeka et al. (2022) The characteristics of RME consist of 5 aspects: contextual challenges, utilization of models and symbols, active participation of students, meaningful interactions, and interconnectedness. These elements have the potential to support educators in fostering effective learning experiences.

This research aims to produce a learning design using a cultural context, namely Chinese Peranakan culture in Tangerang. In the beginning, a learning design is formulated as a Hypotetical Learning Trajectory (HLT). The use Chinese Peranakan culture as a context in learning number pattern has never been used in algebra learning before. Given the challenges encountered by students and drawing upon the findings documented by aforementioned researchers, the present study has crafted a pedagogical pathway termed as a learning design aimed at instructing students on the concept of number patterns through Chinese Peranakan culture context. Previous research by Risdiyanti & Prahmana (2020) shows that a research design to develop a learning trajectory for learning number patterns. The findings indicated that narratives of the Barathayudha war and uno stacko have the potential to enhance students' comprehension of numerical patterns, a crucial component in the cognitive development of learners as they progress through various educational stages. Sari and Nursyahidah (2022) use context of traditional market with interactive video for learning statistics. The result is learning with context of traditional market with interactive can facilitate students in enhancing their comprehension of statistical data representation principles and fostering substantial educational experiences.

## METHODS

The research method used in this research is a research design developed based on the cultural context of Peranakan Chinese in the city of Tangerang through a preliminary study with the stages of pre-field analysis, analysis in the field, and overall data analysis, then a design is developed. Design research is a methodology that encompasses five key characteristics: an interventionist nature, a process-oriented approach, a reflective component, a cyclic character, and a foundation in theory-driven principles. (Akker, Gravemeijer, McKenney & Nieveen, 2006). The three phases in design research are preliminary design, experiment, and retrospective analysis. Explanations of the three phases are:

1. Preliminary Design

At this point, the researcher carried out a theoretical investigation to gain a more thorough understanding of the issue, be able to develop research questions, and be able to suggest workable solutions. This stage includes hypothetical learning trajectories (HLT) as well. In this instance, HLT includes anticipating potential outcomes as well as students' mental processes when addressing the learning process.

2. Design Experiment

Students are used to test the designs that have been created in this step. The purpose of a design research learning experiment is to study how people learn. In this instance, the process of developing students' thought processes within the context and learning environment created by HLT is necessary to ensure that the expectations from the early stages of design are met by reality.

3. Retrospective Analysis

The researcher compared HLT with the actual student learning process during the review's analysis phase. After examining a number of potential causes, the researcher synthesized potential improvements to HLT that could be made for use in the following cycle, there are: initial design, experiment, and analysis of subsequent reviews. The outcomes are utilized as material to compile teaching materials in other materials after getting quality teaching materials through three processes.

This study focused on observing students' learning issues and testing teaching materials. During the first semester of the 2023-2024 school year, learning issues were observed in a class VIII at a junior high school in Tangerang.

## RESULTS AND DISCUSSION

This study's findings provide a description of a hypothetical learning trajectory (HLT) for learning number pattern information within the setting of Chinese Peranakan culture in Tangerang. Furthermore, in this chapter, the researchers discuss the findings from each study stage as follows. Important actions must be taken at the Preliminary Design stage of developing a learning design for number pattern content in order to guarantee the efficacy of the teaching process. Scholars have emphasized how important this stage is for creating learning sequences. Focused creating algebra learning sequences on number patterns using

the Realistic Mathematics Education (RME) concepts (Jupri et al., 2020). This method seeks to improve students' comprehension by integrating real-world and practical situations into the teaching and learning process.

At this stage, the researchers implemented the initial idea of number pattern learning by using the context of Shio Tradition in Chinese culture. The Shio tradition was chosen as the context for this research because it can represent the patterns in the twelve animals that represent specific years, months, and hours in Chinese astrology. In today's society, it is a common misconception that the shio animal symbol is only determined based on the year, in fact the determination of the shio animal symbol is also based on the month, day and hour. In other words, a person has a different shio according to the year, month, day and hour. This would be an interesting topic to discuss with students. The HLT was validated by three experts in mathematics education who familiar with RME approach and Ethnomathematics. Experts approved the following criteria are the contextual problems offered to the students have the potential to assist them in rethinking concepts related to number patterns; and The HLT mirrored the qualities of both teaching and learning as well as instructional design. To improve students' learning experiences and comprehension of mathematical concepts, the Preliminary Design step of developing a learning design on number pattern content entails combining cutting-edge pedagogical approaches and real-world situations.

In Design Experiment, the researchers implemented the learning plan that was designed for SMP students in Grade IX on number pattern material using the shio tradition in Chinese culture. We tested the HLT in small groups. The small group trial's findings demonstrated the effectiveness of the HLT in teaching number patterns within the framework of Chinese culture's shio tradition. The pupils had little trouble learning the material and were able to complete the contextual issue in the allotted time. Students may benefit from the research's expectations and forecasts in order to meet the learning objectives. The trial in the classroom revealed the same circumstance. This indicates that the HLT satisfies the practicability requirement.

The following task was presented to the students in the first activity:

*"Chinese astrology commonly known as shio dates back 2000 years, shio calculations involve the cycle of 12 animals that represent the year a person was born. Here is the order of the shio years: Rat, Ox, Tiger, Rabbit, Dragon, Snake, Horse, Goat, Monkey, Rooster, Dog, Pig. The shio cycle in Chinese astrology starts with the year considered as the year of the rat followed by the year of the buffalo and continues with the next animal"*.

We can see from students' responses that contextual problems help students recognize that their task is to identify patterns and then help them decipher those patterns. Students are invited to see what patterns exist in the Shio tradition in Chinese culture. From the twelve shios, students are directed to look at the numbers or words that are repeated in the row. The teacher uses the pre-planned thought-provoking questions in the HLT to make students think at a deeper level, such as "after observing the patterns in shio, can you describe the shio of a person born in 1974, 1977, 1981, and 1985?" This is the answer given by a student. The answers from students are as follows:

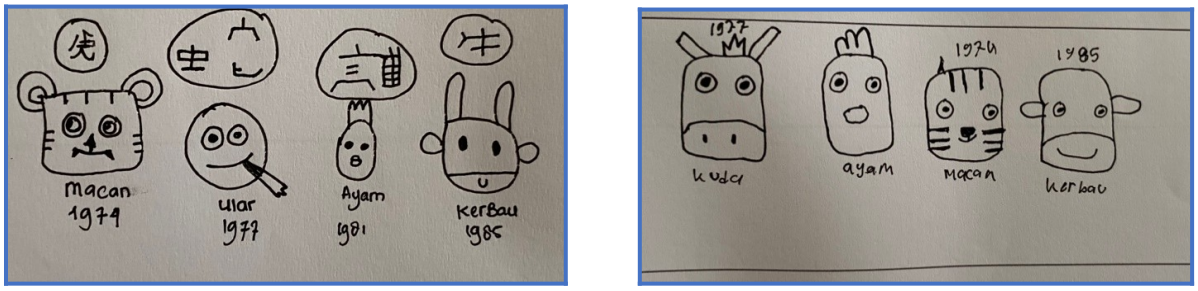


**Figure 1. Student Answers**

Most students can describe the shio found in the years 1974, 1977, 1981, and 1985. From the foregoing explanation, it is clear that the teachers' insightful questions had the potential to encourage students' critical thinking and reasoning. This is in line with research conducted by Fauzan and Diana (2019) that Learning trajectories are highly beneficial in enhancing students' comprehension of mathematical concepts.

In the next section, students are invited to determine the shio for the 30th and 48th years. Students are required to explain the answers that have been made. First, students are invited to see the repetitive patterns found in the Shio tradition in Chinese culture, from

these results, students are given time to work on questions about what shio is in the 30th year and 48th year without having to count them one by one. At the end of the class, students are led to conclude what kind of patterns are found in the shio traditions and explain how they came up with the answers. The answers from the students were as follows.

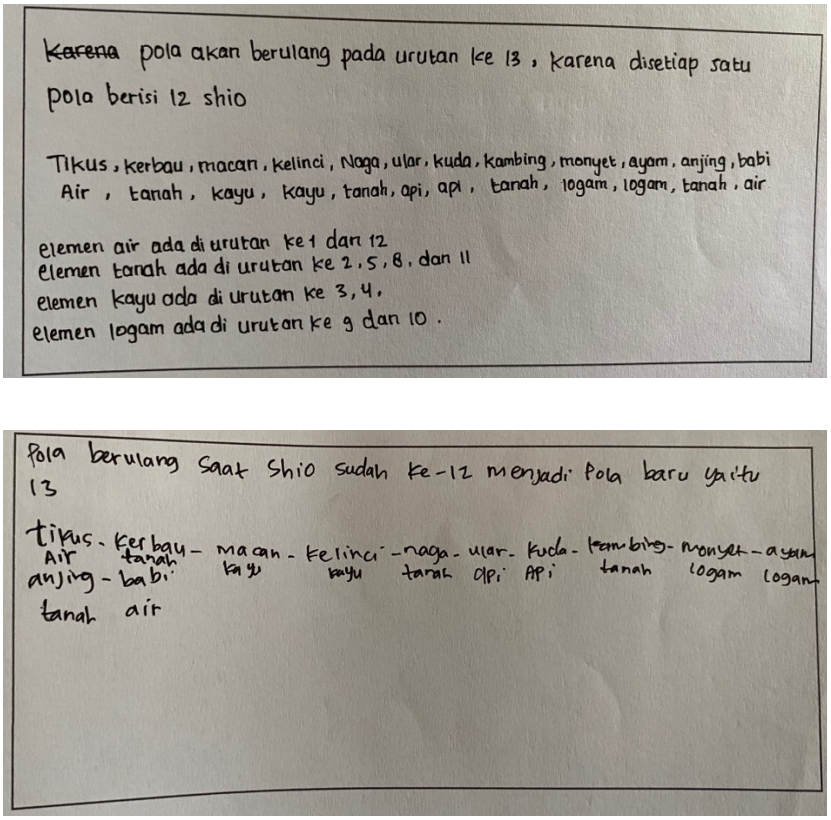


**Figure 2. Student Answers**

The next step is Retrospective Analysis. To address the learning objectives, the HLT acts as a guide. In line with Nursyahidah&Albab (2021) The HLT is compared to the learning process in order to examine and clarify how students might convert non-formal tactics, like number lines, to formal ones. Furthermore, an analysis is conducted between the HLT and the data collected during the design experiment to elucidate the strategies and cognitive processes employed by students in comprehending number pattern content within the provided framework.

As expected, the first question on patterns in the shio tradition showed that students used very good reasoning. Students understand that the purpose of giving the first problem

is to get the pattern formed from the shio tradition. Students realize that there is a repeating pattern of the shio tradition. There are no unclear questions in the learning conjecture, and every student's thought process is anticipated. The responses provided by the pupils demonstrate this. They handled the issues expertly. The results show that an excellent place to start when trying to learn mathematical concepts is ethnomathematics. Teachers can make mathematics learning more interesting and relevant for pupils by introducing ethnomathematics, which is the integration of cultural practices and perspectives into mathematical instruction. Students are more likely to be motivated and involved in the learning process when mathematics is connected to local customs and culture, which improves learning results. Additionally, it has been discovered that ethnomathematics improves students' comprehension of mathematical concepts, problem-solving capabilities, and mathematical communication abilities (Salsabila&Dwipriyoko, 2021; Rizqi&Hawa, 2023).

The next problem showed that students realized there was a repeating pattern in the shio tradition. Students concluded that the arrangement contained in the animal pattern in the shio tradition will repeat when it reaches the 12th order. After getting the repeating pattern, students explain and conclude how the pattern repeats and conclude what is meant by a pattern in a number rule. By teaching mathematics via the RME method, students can acquire the ability to mathematically model various scenarios and cultivate the attitude necessary to use advanced modeling to generalize patterns. Ethnomathematics is being taken far beyond its roots by this mathematization process. Because mathematics is given formally with tested theories, it is understood and taught in schools. According to Nursyahidah&Albab (2021) The formation of HLT, one of the numerous ethnomathematics originating from Indonesia, will greatly enhance RME teaching and learning. Additionally, it would prevent the extinction of national culture and history.

## CONCLUSION

Through this research, we create a learning design for junior high schools that uses the RME technique with culture to teach number patterns. The learning design developed in this study is to create a pattern contained in the shio rules in Chinese culture. Students are better able to comprehend the rules in the subject of number patterns when they are

taught mathematics within the framework of ethnomathematics. The context offers crucial tools for students, explains all sides of the topic, and the shio principles assist students in making inquiries more transparent and accessible to them. During class learning, students exhibit great approaches and reasoning.

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