MaPan : Jurnal Matematika dan Pembelajaran
p-ISSN: 2354-6883 ; e-ISSN: 2581-172X
Volume 13, No 1, June 2025 (1-27)
DOI: https://doi.org/10.24252/mapan.2025v13n1a1

Learning Design Context Musi 6 Bridge on Arithmetic Sequence Material

Sintia Andita[1], Zulkardi[2*], Ely Susanti[3], Meryansumayeka[4]
[1,2,3,4]Program Pendidikan Matematika, Universitas Sriwijaya
[1,2,3,4]Jl. Masjid Al Gazali, Bukit Lama, Sumatera Selatan, Indonesia
Correspondence Email: zulkardi@unsri.ac.id

Received November 29, 2024; Revised March 21, 2025; Accepted May 21, 2025;
Available Online June 22, 2025

Abstract:

Research on the development of learning design, using the context of Jembatan Musi 6, aims to design and develop HLT in this context. The research employs qualitative research methods, specifically the validation study design type, to validate the learning design. The research subjects consisted of 6 people in the pilot stage and 21 people in the teaching experiment stage at the middle school (MTs) Raudhatul Ulum. The development of HLT used a type of research design known as a validation study, a method appropriate for answering research questions and assisting in the development of research design, which can begin with initial design, design experiment, and retrospective analysis. Therefore, these three learning models can be applied to the topic of arithmetic sequences. This research was conducted using interviews, student questionnaires, and student activity sheets to explain the initial activities that started from a real-life context, namely the Musi 6 Bridge, which leads to the basic concept of arithmetic sequences, particularly determining the n-th term formula. Subsequently, the data collection results were analyzed and explained qualitatively based on data analysis, which showed that students could achieve an understanding of the n-th term formula concept using an alternative learning pathway. In the prediction of local theory, the general thinking of the students is quite accurate. The development of this learning design can be used by teachers in the classroom.

Abstrak:

Penelitian mengenai pengembangan desain pembelajaran menggunakan konteks Jembatan Musi 6 pada materi barisan aritmetika menggunakan pendekatan PMRI yang bertujuan untuk merancang dan mengembangkan HLT dalam pengembangan desain ini menggunakan metode penelitian kualitatif desain riset tipe validasi studi. Adapun Subjek penelitian berjumlah 6 orang pada tahap pilot dan berjumlah 21 orang pada tahap teaching eksperimen di MTs Raudhatul Ulum. Pengembangan HLT menggunakan desain reaserch tife validation study cara tepat yang bisa digunakan untuk menjawab pertanyaan penelitian dan membantu pengembangan desain penelitian yang dapat dimulai dengan desain awal, eksperimen desain, dan analisis restrospektif. Maka, tiga model pembelajaran tersebut yang dapat diterapkan pada materi barisan aritmetika. Penelitian ini dilakukan menggunakan proses wawancara, angket siswa, dan lembaran akvitas siswa untuk menjelaskan dari sebuah aktivitas awal yang bermula dari konteks nyata yang ada dikehidupan sehari-hari yaitu Jembatan Musi 6 menjadi konsep dasar barisan aritmetika yaitu menentukan rumus suku ke-n. Selanjutnya hasil dari pengumpulan data tersebut dianalisis dan dideskripsikan secara kualitatif berdasarkan analisis data mendapatkan hasil bawasannya siswa dapat menemukan sebuah pemahaman konsep rumus suku ke-n yang menggunakan alur pembelajaran yang alternatif. Dalam prediksi teori lokal pada cara berpikir siswa secara umum sudah signifikan akurat. Pengembangan desain pembelajaran ini bisa digunakan guru di kelas.

Keywords:
Arithmetic Sequences, PMRI, Musi 6 Bridge

How to Cite: Andita, S., Zulkardi, Susanti, E., & Meryansumayeka. (2025). Learning Design Context Musi 6 Bridge on Arithmetic Sequence Material. *MaPan : Jurnal Matematika dan Pembelajaran*, *13*(1), 1-27. https://doi.org/10.24252/mapan.2025v13n1a1.

INTRODUCTION

Mathematics is an important subject to learn (Simamora, Hernaeny, & Hasanah, 2023). However, for some students, mathematics is considered the most terrifying subject, which makes them struggle in learning (Mufakat & Usman, 2020). One of the difficulties is in solving problems. In the topic of arithmetic series, this is one of the subjects that requires various solution methods, thus requiring a high level of problem-solving skills (Zulfikar, Achmad, & Fitriani, 2018). Due to the material on arithmetic sequences, students are not only required to solve problems using existing formulas, but they also need imagination and creative thinking (Simamora, Hernaeny, & Hasanah, 2023). The difficulty is very apparent when it comes to teaching that requires students to use reasoning and first create mathematical sentences (Mufakat & Usman, 2020). According to Bouty, Pradana, and Sasomo (2022), based on the analysis results in solving arithmetic sequence problems, all subjects made similar types of errors, namely, transformation errors and process errors. These errors occurred because students incorrectly selected the mathematical form the information obtained, made mistakes in calculation steps, and could not solve the problems according to the procedure. Based on that statement, the reality is that the condition of students in the field has not been achieved well.

In this case, many scientists are developing innovations in mathematics education (Marsigit, Condromukti, Setiana, & Hardiarti, 2018). This is related to one of the components in the learning process standards in the 2013 curriculum, which states that learning must be conducted using interactive, enjoyable, creative, challenging, and motivating methods and approaches for students (Setyaedhi, 2021). Therefore, the selection of the learning approach to be applied to the teaching material will influence the development of students' skills to interpret situations through mathematical modeling and connect them with mathematical concepts. One of the approaches that can facilitate this issue is the Realistic Mathematics Education approach (Haryonik & Bhakti, 2018).

In using the realistic mathematics education approach, it is necessary to use a context in mathematics learning. Many things around us are related to mathematics (Simamora, Hernaeny, & Hasanah, 2023). Concrete things with students' daily experiences can be used as interesting learning resources (Marsigit, Condromukti, Setiana, & Hardiarti, 2018). Students can carry out activities to rediscover existing mathematical properties or theories by solving the application of Indonesian realistic mathematics education (PMRI) in mathematics learning problems informally (Zulkardi, Putri, Somakim, Kurniadi, Sukmaningthias, & Simarmata, 2022). Based on the description above, it is necessary to develop teaching materials using the PMRI approach (Noviani & Firmansyah, 2020). So in this case, the researcher created teaching materials using the PMRI approach that are related to everyday life, namely, using the context of the Musi 6 bridge.

Musi 6 bridge is a bridge infrastructure development project that aims to invite the public to reduce congestion on the Ampera bridge (Jannah & Minako, 2023). In the context of the Musi 6 bridge, there is an iron frame that can be calculated easily, namely using arithmetic series material. So in learning, it is better to prioritize understanding the concept of number pattern material so that learning can be more meaningful (Mufakat & Usman, 2020). At the time of the observation, some students still did not understand the concept of arithmetic series, and the teaching materials used by mathematics teachers at MTs Raudhatul Ulum uses teaching materials based on printed books, not to mention other innovations in teaching materials. So, some students feel bored and less interested in learning the arithmetic series material.

Therefore, from the results of the observation, the researcher took the initiative to develop a new teaching material that can be used by teachers in the learning process in the classroom on the material of arithmetic sequences with the context of the Musi 6 bridge using the PMRI approach. This teaching material is in the form of a student activity sheet (LAS). In the LAS, there are instructions for completing learning tasks related to interpreting something through mathematical modeling and connecting it to mathematical concepts (Haryonik & Bhakti, 2018). Design materials by the PMRI applied (Andita, Syutaridho, & Nizar, 2024). The PMRI approach to learning uses real contexts that students have experienced, so that it can be a bridge from context to formal mathematics (Mubharokh, Zulkardi, Putri, & Susanti, 2022). The use of this context enables students to explore and model by interacting with group members so that learning is achieved for all students (Feriana & Putri, 2016).

So in this case, the author raises a research title, namely "Learning Design of Musi 6 Bridge Context on Arithmetic Sequence Material for Grade 7 Junior High School". The focus of the problem formulation in this study is how to produce a learning design that can be useful for students in understanding arithmetic sequence material. In line with several previous studies (Fazira & Rismawati, 2024). Regarding the development of this learning module is very effective to use in learning activities and increase students' knowledge about local Acehnese culture, which can be completed using the arithmetic series material. In addition to Acehnese local wisdom, there is research and development. Dewi, Kinanti, and Sulistyorini (2020) namely, the arithmetic sequence pattern found in the beats in Gending Ketawang. And there are similarities with the development research. Falah, Marhayati, and Fa'ani (2022) also about the arithmetic sequence pattern on the rhythm of the Gending Lancaran in the art of Gamelan Tembung Dolanan musical instruments. Previous research in the development of arithmetic sequence material used various contexts in their respective research areas. From the various contexts used, there are similarities in the discussion, namely the application of the concept of arithmetic sequence material so that in this study, there are differences and innovations in the development of the context, namely the Musi 6 bridge which is one of the Icons of Palembang City in the arithmetic sequence material.

Apart from the differences in context from the previous research, the current research uses the type of validity study design method in the design of the classroom and presents the results qualitatively, while the previous research uses the R&D method and the ADDIE model to present the results quantitatively. Prior research focused more on media development; however, this study focuses on educational design that is appropriate for students and adults, describing the exploration of arithmetic sequence patterns in the rhythm beat of Gending Lancaran. However, the results of this study show that the design of education is not just different in the context of the Musi 6 bridge, which provides a thorough analysis of the context through the PMRI that is provided through the context. As a result, students may understand concepts that are fundamental and can recognize concepts from the "rumus barisan aritmetika". By having a research objective, namely to produce new teaching materials in the form of student activity sheets with the context of the Musi 6 bridge using the PMRI approach. The teaching materials developed can be expected to be used by teachers in teaching and can help students understand the concept of arithmetic sequences independently.

METHODS

This validation study aimed to develop a hypothetical learning trajectory (HLT) (Adiningsih, Rahmawati, & Chasanah, 2023). Before designing the learning model, the researcher analyzed student difficulties at MTs Raudhatul Ulum uses a 5-question arithmetic sequence assessment and learning needs analysis. Based on these findings, a tailored learning design was created. The sample included six class VIII students for the initial stage and 21 for the full-class test. Data were collected through interviews, questionnaires, and student activity sheets (LAS), then analyzed. Feedback from FGD with experts and peers informed the HLT development. The process followed Gravemeijer's (2016) three design research stages: (a) preparation, (b) design experiment, and (c) retrospective analysis.

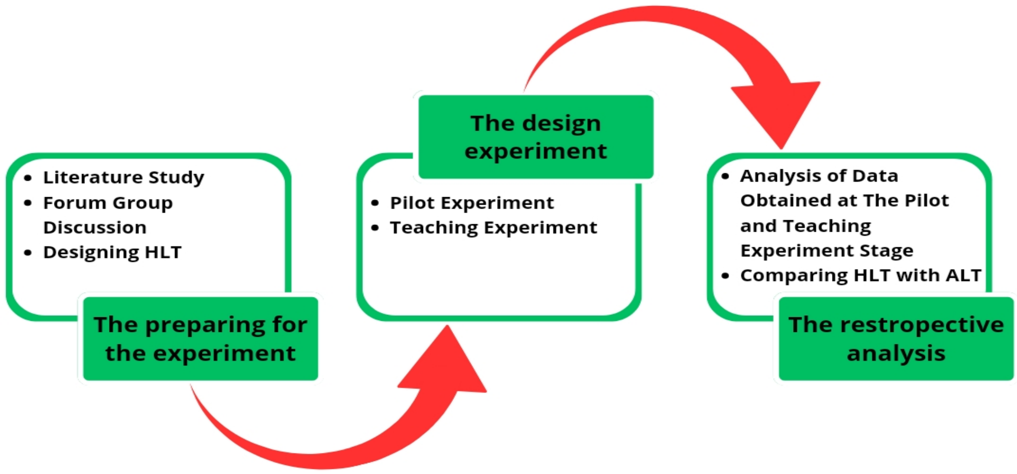


Figure 1. Design Research Stages

The first stage is research preparation (preparing for the experiment), where researchers identify student difficulties through direct surveys and assess student abilities related to challenging content. These findings guide the development of learning plans and RPP focused on those difficulties. Hypothetical Learning Trajectories (HLT) are then formed based on prior insights into student learning interactions (Hendrik, Ekowati, & Samo, 2020). Researchers study relevant literature to align the learning context with the Class 8 Revised K13 curriculum at MTs Raudhatul Ulum. Student activity sheets using the Musi 6 Bridge context serve as innovative teaching materials. The outcomes of this stage inform the design of HLT, containing temporary assumptions and structured learning activities.

The second stage is the design experiment, consisting of two cycles: a pilot experiment (cycle 1) with 6 students of varying abilities, where the researcher acted as the teacher, and a teaching experiment (cycle 2) with a full class, where the teacher implemented the lesson and the researcher observed. Results from cycle 1 were used to revise the initial HLT. The final stage was a retrospective analysis to develop the local instructional theory (LIT) by processing data from the teaching experiments to inform future learning designs.

RESULTS AND DISCUSSION

1. Initial Design

At this stage, the researcher collaborated with the teacher to refine the initial teaching material design using the Musi 6 Bridge context, focusing on its iron arch structure linked to arithmetic sequences. The material was aligned with the grade VIII K13 curriculum. Discussions also covered the research design, student activity sheets, instruments, and the PMRI approach. Data were collected through observation, interviews, and documentation (Utari, Putri, & Zulkardi, 2024). In stage 1 (preparing for the experiment), a literature review, curriculum analysis, and discussions with PMRI course lecturers were conducted. Based on relevant theories (Ali, Ratnaningsih, & Prabawati, 2024), HLT was developed to enhance mathematical thinking and avoid misconceptions. The HLT, designed for arithmetic sequences in the Musi 6 bridge context, builds on previous research like (Ramadona, Zulkardi, & Putri, 2023) which used the same context for triangle material. The study emphasizes the need for a well-applied HLT to become an Actual Learning Trajectory (ALT). The HLT includes three components: learning goals, activities, and hypothetical learning processes, as shown in table 1.

Table 1. HLT Design

Learning Goal	Learning Activities	Hypothetical Learning Processes/Conjecture
To understand the nth term formula of an arithmetic sequence through the context of the Musi 6 Bridge.	Activity 1 (questions 1–3): Exploring number patterns through the Musi 6 Bridge. 1. Students observe the bridge's side view. 2. They discuss information from the image. 3. They estimate the number of partitions in the arch.	1. Blurry images cause observation errors. 2. Students see the iron structure but are unsure which parts to count. 3. They can identify the number of partitions. 4. Some struggle due to an unclear understanding of the term "partition."
Understanding the nth term formula of an arithmetic sequence through the Musi 6 Bridge context	Activity 2 (questions 4–5): Determine the number of iron pieces in each partition and the difference between them.	Students can find out the number of pieces of iron per partition.
Understand how to determine the amount of iron through the difference in the number of partitions that have been given in the next image, and try to calculate the total amount of iron in the arch of the Musi 6 bridge.	Activity 3 (question 6): Find the number of pieces of iron. 1. Students are able to count the iron that appears in the picture, which has a few partitions starting from partition 1 to 10. 2. Students find the difference between the partitions and how many pieces of iron there are on the arch of the bridge. 3. Students can calculate the bridge	1. Students can manually count iron pieces across several partitions. 2. They can distinguish iron pieces in pictures 1 and 2, but struggle with the differences between pictures 3 and 4. 3. Some understand that the first partition splits into two equal parts when combined with others. 4. Students successfully apply arithmetic sequences to calculate

Learning Goal	Learning Activities	Hypothetical Learning Processes/Conjecture
	using the arithmetic sequence formula.	iron pieces on the Musi 6 Bridge arch.
Generalizing from context to the nth term formula for arithmetic sequence material	Activity 4 (question 6): Find the iron pieces from partition 1 to partition 36.	1. Students understand the nth term formula in an arithmetic series. 2. They apply it to solve real-world problems.

Table 1 shows the relevance of the HLT, which was reviewed through an FGD involving two Mathematics Education experts, a PMRI expert, and peers. Feedback included correcting typos, clarifying images and language, avoiding confusion between questions 3 and 4, using consistent capitalization for "Musi 6 Bridge," and replacing unclear terms like "pattern" to prevent misunderstanding. Suggestions also included adding views beyond the side view and revising or removing items 1–6 if not aligned with research goals. The researcher will revise the HLT based on this feedback before retesting it in the pilot and teaching experiment stages.

2. Design Experiment

a. Pilot experiment

In the pilot experiment stage, the first trial was conducted, namely, 6 subjects who had high, medium, and low abilities. In this trial process, the considerations in improving suggestions and comments on students' understanding of the HLT that was created. The following are students' answers to the revised HLT from the FGD stage.

Dialog 1 : Situasional

Teacher: Do you know the Musi 6 Bridge?

Student: I don't know, because I've never crossed the bridge.

Teacher: Do you know the function of the iron on the arch of the Musi 6 Bridge?

Student: I don't know, maybe it's just for decoration, so it looks beautiful from the side.

Teacher: The iron on the arch of the Musi 6 Bridge functions to support the road on the bridge.

Student: Hum, it means Umi, without the arch, there is no road support.

Activity 1: Identifying Arches on the Musi 6 Bridge

In this first activity, students are asked to look at the side view of the bridge and answer several questions that lead to the identification of the bulkhead on the Musi 6 Bridge. Table 2 below is the representative answer from 6 students to several questions given.

Table 2. Activity 1 of the Pilot Experiment Phase

English Version	Students' Answer (Indonesian Version)
Do you see the arch of the bridge? Answer: Group 1 and 2 Same answer	Group 1 ya, bisa Group 2 Bisa, jika dilihat dari samping
What patterns are there on the Musi 6 bridge when viewed from the side? Answer: Group 1 Curved, straight, zigzag, and triangular patterns Group 2 Triangles, curved lines, and vertical lines.	Group 1 Pola melengkung, lurus, zigzag, segitiga Group 2 Segitiga, garis lengkung, garis vertikal,
Pay attention to the perpendicular iron border on the bridge. On the upper border of the iron, there is a triangular pattern. Based on the statement, describe how many triangles form the arch of the bridge? Answer: Group 1 and 2 Same answer: 8 triangles	Group 1 8 Segitiga Group 2 ada 8 pola segitiga pada jembatan tersebut

In table 2, activity 1, groups 1 and 2 gave the same answers for questions 1 and 3. For question 2, their answers slightly differed-group 1 mentioned curved, straight, zigzag, and triangle patterns, while group 2 noted triangles, curved lines, and vertical lines. Despite this, both groups showed understanding of the questions.

Activity 2: Understanding the Partitions in the Triangular Pattern Image on the Musi 6 Bridge Arch

Next, the second activity is seen in table 3, understanding the partition in the image that limits the triangular pattern in the bridge arch. The following is the explanation in table 3.

Table 3. Answers to Activity 2 in the Pilot Experiment

English Version	Students' Answer (Indonesian Version)
How many triangle patterns are there in picture 4 on the arch of the Musi 6 bridge? Answer: Group 1 and 2 Same answer: 72 triangle patterns	Group 1 72 pola segitiga Group 2 ada 72 pola segitiga pada gambar diatas
List in order the number of pieces of iron that form a triangle in picture a, picture b, picture c, and picture d. If it is known that picture a has 1 partition, picture b has 2 partitions, picture c has 3 partitions, and picture d has 4 partitions? Answer: Group 1 and 2 Same answers 5,9,13,17	Group 1 gambar a : 5 gambar b : 9 gambar c : 13 gambar d : 17 5 , 9 , 13 , 17 4 4 4 Group 2 Ga : 5 G.c : 13 G.b : 9 G.D. : 17 5.9.13.17.

In activity 2, some group 2 students were initially confused but answered correctly after discussion. However, they struggled to understand the example image about arithmetic sequences. To clarify, the teacher interviewed students, one of whom said they didn't grasp how the image parts related to sequence numbers.

The researcher explained that the image cuts represented partition boundaries marked by vertical iron bars and guided students toward understanding in preparation for activity 3.

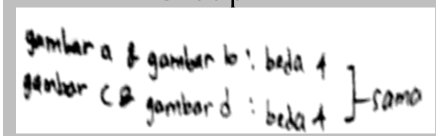
Activity 3: From question number 5, how many differences are there in the cuts of iron between picture a and picture b, between picture c and picture d? Are the differences the same?

Activity 3 begins to determine the difference in each existing partition, as seen in table 4 of the student answers. Here is table 4 of activity 3 of the pilot experiment.

Table 3. Answers to Activity 3 in the Pilot Experiment

Students' Answer (Indonesian Version)

Group 1	Group 2


gambar a & gambar b : beda 4
gambar c & gambar d : beda 4 } sama

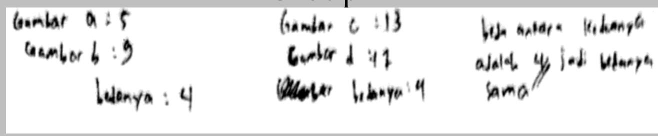

Gambar a : 5
Gambar b : 9
bedanya : 4
Gambar c : 13
Gambar d : 17
bedanya : 4
beda antara keduanya adalah 4 jadi bedanya sama

Table 3 in activity 3 includes a question about the differences between partitions. Both groups correctly identified a consistent difference of 4 iron pieces, though they didn't use a formula. Students referred to "pictures" instead of "partitions," showing some confusion due to unclear question wording, which led to answers not fully matching the expected outcome.

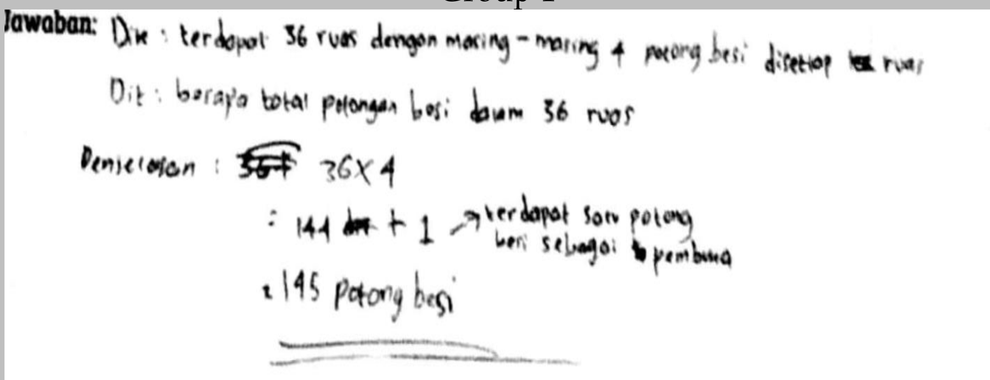
Activity 4: Counting Iron Pieces in the Arch of the Musi 6 Bridge Using Arithmetic Sequence Formulas.

Activity 4 begins to determine the amount of iron contained in the arch of the Musi Bridge 6. In each existing partition, the students' answers are shown in table 5. Here is table 5 of activity 4 of the pilot experiment.

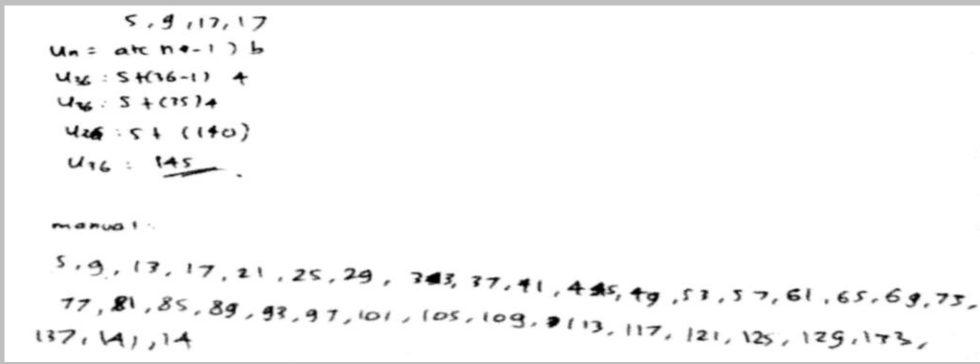
Table 5. Answers to Activity 4 in the Pilot Experiment

Students' Answer (Indonesian Version)

Group 1

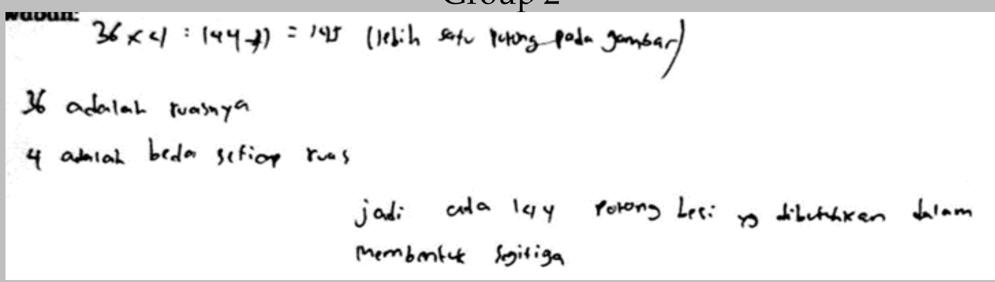

Jawaban: Dik : terdapat 36 ruas dengan masing-masing 4 potong besi disetiap ruas
Dit : berapa total potongan besi dalam 36 ruas
Penyelesaian : 36x4
= 144 + 1 → terdapat satu potong besi sebagai pembuka
= 145 potong besi

Students' Answer (Indonesian Version)


5, 9, 13, 17
Un = a + (n-1) b
U36 = 5 + (36-1) 4
U36 = 5 + (35) 4
U36 = 5 + (140)
U36 = 145

manual:
5, 9, 13, 17, 21, 25, 29, 33, 37, 41, 45, 49, 53, 57, 61, 65, 69, 73, 77, 81, 85, 89, 93, 97, 101, 105, 109, 113, 117, 121, 125, 129, 173, 137, 141, 14

Group 2


36 × 4 = (144 + 1) = 145 (lebih satu potong pada gambar)
36 adalah rusuknya
4 adalah beda setiap rusuk
jadi ada 144 potong besi yg dibutuhkan dalam membentuk segitiga

In table 5 of activity 4, one question asks for the amount of iron on the Musi 6 bridge arch. Group 1 uses the arithmetic sequence formula, while Group 2 applies analogies and creative methods, both arriving at 145 pieces. However, the activity reveals conceptual gaps in understanding arithmetic sequences. Feedback suggests revising questions to better guide students in discovering concepts, ensuring clarity in language, aligning activities progressively, and improving visual clarity. The HLT will be revised and retested in the teaching stage.

b. Teaching experiment

There are two cycles in the design experiment stage: teaching experiments and pilot experiments are checked and tested. Changes in HLT are influenced by strategies that have not been implemented, activities that are not easily understood by students, or are too difficult to implement. Some HLTs are revised to provide ideal HLT improvements. Based on the hypothetical learning trajectory (HLT), which has been tested in the draft at the design experiment stage after consulting with lecturers and teachers. This study provides an impact on developing learning trajectories about 'finding the formula for the nth term of an arithmetic series' through several learning activities for eighth-grade students.

In the HLT activity, there are 2 activities with 4 questions and 4 activities each. A total of 21 students in 1 class will be tested on the redesigned HLT and given back to students with different subjects. Furthermore, the teacher will provide LAS sheets in the context of the Musi 6 bridge.

Dialog 2 : Situasional

Teacher: Do you know the iron frame that makes up the Musi 6 bridge?
Student: Yes, I know. But I've never been there.
Teacher: Do you know the function of the iron on the arch of the Musi 6 bridge?
Student: Yes, the function of the iron on the arch of the Musi Bridge is to connect the Seberang Ulu sub-district and the Ilir Barat 2 sub-district.

Activity 1: Identifying the Partitions on the Musi 6 Bridge

In the learning target for activity 1, students can identify and understand number sequences. The first activity is related to contextual mathematics with 'Musi Bridge 6 side view' as the real context given in table 6 below.

Table 6. Activity 1 in the Teaching Experiment Stage

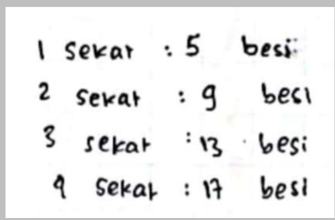
English Version	Students' Answer (Indonesian Version)
What is known in Information 1? Answer: The iron frame that makes up the Musi 6 bridge has a pattern that bears on every opportunity. Each iron partition that pushes the stilts continues on the bridge.	Kerangka besi yang menyusun jembatan Musi 6 memiliki pola yang berulang pada setiap partisi. partisi besi yang menggantung dan tegak lurus dengan jembatan. Partisinya besi gantung tersebut berjumlah 37 partisi, memiliki 1 sekat antara 2 partisi. Total sekat pada lengkungan jembatan adalah 36 sekat.
How many partitions are there in picture 3, picture 4, picture 5, and picture 6? Answer: Picture 3: 1 partition Picture 4: 2 partitions Picture 5: 3 partitions Picture 6: 4 partitions	gambar 3 : 1 Sekat gambar 4 : 2 sekat gambar 5 : 3 Sekat gambar 6 : 4 Sekat

Based on table 6, students recognize a pattern in the iron partitions by observing each section of the Musi 6 bridge arch and its addition rule. When asked, they identify the number of partitions in each image and correctly record the partitions from pictures 3 to 6.

Activity 2: (Question 3) In picture 3, there is 1 partition. How much iron is in the arch for 1 partition? Next, write down the amount of iron for 2 partitions, 3 partitions, and 4 partitions in sequence.

In this activity, the aim is for students to be able to find number patterns and find arithmetic sequence formulas using the nth term formula. The teacher reminds students about the context of the Musi 6 bridge, which has arches and partitions in each picture in the previous activity, and asks students to observe table 7 of activity 2 given.

Table 7. Activity 2 in the Stage Teaching Experiment

English Version	Students' Answer (Indonesian Version)
Student 1: Each partition has pieces of iron that will be added. The more partitions, the more additional pieces of iron, and for example: 1 partition: 5 irons 2 partitions: 9 irons 3 partitions: 13 irons 4 partitions: 17 irons	Student 1:  1 sekat : 5 besi 2 sekat : 9 besi 3 sekat : 13 besi 4 sekat : 17 besi
Student 2: Picture 3: 5 iron Picture 4: 9 iron Picture 5: 13 iron Picture 6: 17 iron	Student 2:  g a m b a r 3 : 5 b e s i g a m b a r 4 : 9 b e s i g a m b a r 5 : 13 besi g a m b a r 6 : 17 besi

Through activity 2 in table 7 in this activity, student 1 has been able to determine the pattern of the number of iron pieces in each partition by counting the number of iron pieces in each partition, as illustrated in the picture. Student 2 shows that they understand that counting iron pieces involves using pictures related to the number of iron pieces in each picture.

Activity 2: (Question 4) How much is the difference in the iron frame in the arch of the bridge between 1 partition and 2 partitions? The difference is…. Next, between 3 partitions and 4 partitions, the difference is…. Are the differences the same?

In question 2, to find out whether students understand the concept of "difference" in arithmetic series, question 2 of this activity asks students to determine the difference in the number of pieces of iron between the partitions in the arch of the Musi 6 bridge. The following are students' answers in table 8, activity 2, question 4.

Table 8. Activity 2 of the Teaching Experiment Stage

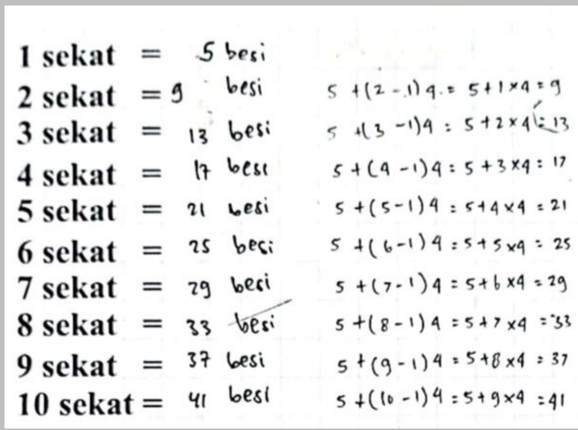
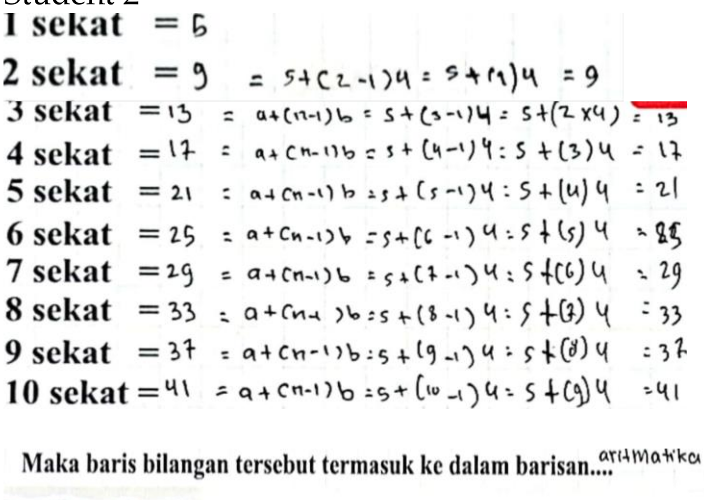
English Version	Students' Answer (Indonesian Version)
Student 1 Between 1 partition and 2 partitions, the difference is 4 iron 3 and 4 partitions, the difference is: 4 Same	Student 1: Jawaban: antara 1 sekat dan 2 sekat bedanya : 4 besi sama 3 dan 4 sekat bedanya : 4
Student 2 Between 1 partition and 2 partitions, the difference is 4 iron Between 3 and 4 partitions, the difference is: 4	Student 2: 1 antara 1 sekat dan 2 sekat bedanya 4 antara 3 sekat dan 4 sekat bedanya 4

In table 8 in this activity, after being interviewed, student 1 looked for the difference between the number of 2 adjacent partitions by simply subtracting the number of irons in partition 2 from the number of irons in partition 1. So that the student was able to know that the difference in each partition was 4. Even though he did not write it in the form of a formula " $b = U_n - U_{n-1}$"

Activity 3: (Question 5) Determine in sequence the amount of iron starting from 1 partition to 10 partitions! Write it in a form that is as creative as possible so that it can be understood

Students are asked to calculate how much iron there is in 1 bulkhead to 10 bulkheads on the arch of the Musi 6 bridge. Students are also asked to write down how they found it as creatively as possible in the calculations used to solve the problem. At this stage, students are expected to provide calculations that lead to the formula for the nth term in the arithmetic sequence. It can be seen in the following table 9.

Table 9. Activity 3 in the Stages of Teaching Experiment

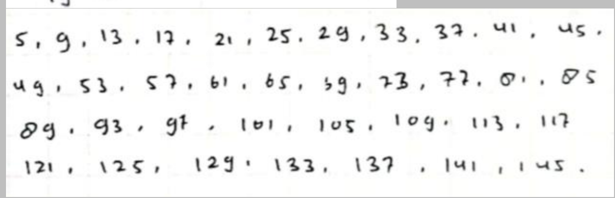
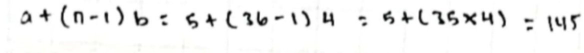
English Version	Students' Answer (Indonesian Version)
Student 1 It can be seen in the picture that he has been able to complete it well, but has not written the formula for the nth term. And he still has not answered what sequence it belongs to?	Student 1  1 sekat = 5 besi 2 sekat = 9 besi 5 +(2 - 1)4 = 5+1×4 = 9 3 sekat = 13 besi 5 +(3 - 1)4 = 5+2×4 = 13 4 sekat = 17 besi 5 +(4 - 1)4 = 5+3×4 = 17 5 sekat = 21 besi 5 +(5 - 1)4 = 5+4×4 = 21 6 sekat = 25 besi 5 +(6 - 1)4 = 5+5×4 = 25 7 sekat = 29 besi 5 +(7 - 1)4 = 5+6×4 = 29 8 sekat = 33 besi 5 +(8 - 1)4 = 5+7×4 = 33 9 sekat = 37 besi 5 +(9 - 1)4 = 5+8×4 = 37 10 sekat = 41 besi 5 +(10 - 1)4 = 5+9×4 = 41
Student 2 It can be seen that the answer is already pointing to the formula for the nth term, and they can identify that the sequence of numbers they are looking for is an arithmetic sequence.	Student 2  1 sekat = 5 2 sekat = 9 = 5+(2-1)4 = 5+(1)4 = 9 3 sekat = 13 = a+(n-1)b = 5+(3-1)4 = 5+(2×4) = 13 4 sekat = 17 = a+(n-1)b = 5+(4-1)4 = 5+(3)4 = 17 5 sekat = 21 = a+(n-1)b = 5+(5-1)4 = 5+(4)4 = 21 6 sekat = 25 = a+(n-1)b = 5+(6-1)4 = 5+(5)4 = 25 7 sekat = 29 = a+(n-1)b = 5+(7-1)4 = 5+(6)4 = 29 8 sekat = 33 = a+(n-1)b = 5+(8-1)4 = 5+(7)4 = 33 9 sekat = 37 = a+(n-1)b = 5+(9-1)4 = 5+(8)4 = 37 10 sekat = 41 = a+(n-1)b = 5+(10-1)4 = 5+(9)4 = 41 Maka baris bilangan tersebut termasuk ke dalam barisan.... aritmatika

Throughout this activity, students have been directed to create mathematical modeling, and it is clear that the student's model leads to the formula for the nth term in an arithmetic sequence, which is seen in the student's answer in table 9 above. Students write, for example, for 4 partitions 5+(4—1)×4 = 5+3×4 = 17 in answering the question, students can generalize it. When interviewed, it can be obtained from the answer. The student answered, "5 is the first partition, for (4 — 1) it can be obtained from the 4th partition minus the first partition, and times 4, each partition has a difference of 4". So it can be concluded that through this activity, students can find the formula for the nth term, namely "$U_n = a + (n-1)b$".

Activity 4(Question 6): Can you help Toni determine the amount of iron contained in the 36 partitions in the side view of the Musi 6 bridge arch! Explain how you did it!

In this activity, students are asked to determine the amount of iron in the 36 partitions in the arch of the Musi 6 bridge. By providing an initial goal for calculating the amount of iron in the arch of the Musi 6 bridge. Then students can generalize mathematics formally, namely, using the formula for the nth term of an arithmetic sequence. It can be seen in the students' answers in table 10 as follows.

Table 10. Activity 4 of the Teaching Experiment Stage

English Version	Students' Answer (Indonesian Version)
Student 1 Answer: 11 partitions: 41+4=45 12 partitions: 45+4=49 Up to 19 partitions as in the picture Next, they make a sequence of number patterns starting from the first number of the first partition to the last The number of irons in the 36 partitions in the arch of the Musi 6 bridge is = 145 irons	Student 1  11 sekat = 41 + 4 = 45 12 sekat = 45 + 4 = 49 13 sekat = 49 + 4 = 53 14 sekat = 53 + 4 = 57 15 sekat = 57 + 4 = 61 16 sekat = 61 + 4 = 65 17 sekat = 65 + 4 = 69 18 sekat = 69 + 4 = 73 19 sekat = 73 + 4 = 77  5, 9, 13, 17, 21, 25, 29, 33, 37, 41, 45, 49, 53, 57, 61, 65, 69, 73, 77, 81, 85, 89, 93, 97, 101, 105, 109, 113, 117, 121, 125, 129, 133, 137, 141, 145.
Student 2 Can already generalize using formulas $\boldsymbol{U_n}$ $\boldsymbol{U_n = U_1 + (n-1) \times b}$ So the formula for the nth term in an arithmetic series is to get the result, namely 145 iron.	Student 2  a+(n-1)b = 5+(36-1)4 = 5+(35×4) = 145

Based on table 10 from activity 4, it can be seen that students can use the formula obtained from the previous calculation in activity 3 and use it to answer activity 4 question number 6. After that, students generalize the nth term by stating the arithmetic sequence formula.

3. The Restropective Analysis

At this stage, the results of the pilot experiment stage and the teaching experiment stage are compared. Of the two stages, students understand better and are more enthusiastic about working on and finding the U_n formula well. The following images 2 and 3 are screenshots of the welding display at the pilot experiment and teaching experiment stages.

Figure 2. Pilot Experiment Stage

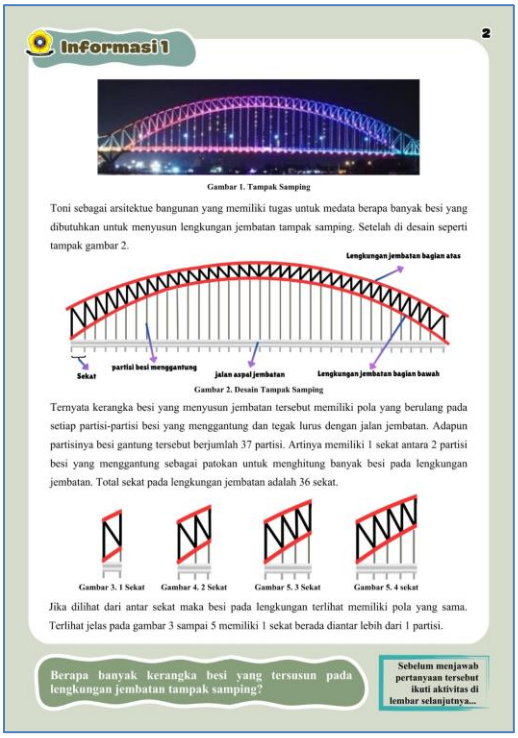


Figure 3. Teaching Experiment Stage

Figures 2 and 3 show the differences in HLT designs that were tested on students in figure 2, the pilot experiment stage and figure 3) and the teaching experiment stage. It was seen during the interview with students that they understood information 1 better because the words were as clear as the illustration of the bridge, which was good and interesting to learn. Some student input was adjusted and revised so that the HLT could be used as new teaching materials for teachers for grade 8 students.

In addition to Information 1 in the HLT, Information 2 is provided to assess students' understanding through activities involving iron calculations on the Musi 6 bridge arch. Based on retrospective analysis (stage 3) and teaching experiments using the PMRI approach, the HLT was refined to help students independently discover concepts. The success of HLT supports the creation of a local instructional theory (LIT), as it effectively guides learning aligned with PMRI principles—from real-world contexts like climate change to formal mathematical concepts (Friansah, Zulkardi, Susanti, & Nusantara, 2024). HLT is then compared to the actual learning trajectory (ALT) observed in the classroom (Utari, Putri, & Zulkardi, 2024).

Table 11. Comparison between HLT & ALT of Activity

Activity	HLT	ALT
1. Read headlines and text related to the Musi 6 Bridge issue. 2. Able to identify key information in texts about barriers on the Musi 6 Bridge.	1. Students can accurately read headlines and news about the Musi 6 bridge issue. 2. Students can identify key information about the iron frame, barriers, and arches of the Musi 6 Bridge, including their supporting structures.	1. Students decide without fully reading the text. 2. Students read the text correctly. 3. Students can understand and apply key concepts of triangular iron frame patterns and their boundary walls.
1. Estimate the iron in one partition from figure 3, then predict the total for two, three, and four arch partitions of the Musi 6 Bridge. 2. Predict the differences between one, two, three, and four partitions to determine if the changes are consistent.	1. Students predict the iron amount in each partition by observing the 3-arch image of the Musi 6 Bridge. 2. Students compare partitions to identify differences and derive their formula for the variation.	1. Students can predict and calculate the iron in each Musi 6 Bridge arch partition. 2. They understand this follows a numerical sequence pattern based on iron pieces per partition. 3. They have derived a formula by subtracting the iron in one partition from that in two.

Activity	HLT	ALT
Determine the amount of iron from one to ten partitions in sequence.	This third activity encourages students to creatively predict the number of iron pieces in the next partition and discover their arithmetic formula.	Students begin by understanding each partition as a term in a sequence and use this to partially derive the correct arithmetic formula. Most can then calculate the iron in the first 10 partitions using the formula, while some still rely on manual calculations due to limited understanding.
Interpreting and solving Toni's problem in calculating the iron in 36 partitions of the Musi 6 Bridge	Students use social arithmetic formulas to quickly and accurately determine the amount of iron in the Musi 6 Bridge arch.	1. Students use social arithmetic formulas to calculate the total iron on the Musi 6 Bridge. 2. Some students verify their results manually or by using number patterns, but more than half correctly apply the formulas.

Table 11 shows that the activities based on the predicted hypothesis align closely with the Actual Learning Trajectory (ALT). Some students with low ability levels still have difficulty understanding the questions given and cannot solve them using the concept of arithmetic sequences. Several similar case studies have shown that providing Student Activity Sheets (LAS) based on contexts that are relevant to everyday life, such as calculating the number of tiles on the floor or the number of chairs in a row, can improve the understanding of students who previously had difficulty understanding the concept of sequences and series (Ramadona, Agustiani, Zahra, & Putri, 2023). From this problem, the solution provided is particularly within the PMRI (Indonesian Realistic Mathematics Education) framework, the role of the teacher is not merely to deliver information, but to guide students in understanding contextual problems and support them in constructing their solutions. This approach is in line with the concept of guided reinvention, where students are encouraged to rediscover mathematical ideas through carefully designed learning trajectories with the teacher's facilitation (Gravemeijer & Doorman, 1999). In this context, the teacher acts as a facilitator who provides questions, prompts, and representations that help students connect real-world contexts with formal mathematical concepts.

Guided reinvention requires teachers to anticipate students' strategies and misconceptions, then scaffold their thinking toward more formal reasoning (Zulkardi & Putri, 2020). This process was evident during the implementation of the Musi 6 Bridge context, where students initially observed patterns in iron structures and gradually discovered arithmetic sequences. However, not all students reached the solution independently; some needed further guidance through visual aids or leading questions. This supports the findings of (Fauzan, Zulkardi, & Nieveen, 2020), who emphasize that effective scaffolding within PMRI allows students to meaningfully connect their intuitive understanding with mathematical models. Moreover, Hidayat, Nurfadilla, and Dewi (2021) point out that students with lower mathematical abilities particularly benefit from this teacher guidance, as it bridges the gap between real-world situations and abstract reasoning. Thus, teachers must continuously adapt their facilitation based on student responses, promoting active thinking rather than passive reception. Through guided reinvention, supported by contextual activities, students not only solve problems but also develop deeper conceptual understanding and problem-solving confidence.

Although contextual approaches such as Indonesian realistic mathematics education (PMRI) have proven effective in helping students understand mathematical concepts more concretely, in reality, there are still students who struggle to grasp the concept of arithmetic sequences. This indicates that using real-life contexts alone is not necessarily sufficient to ensure deep conceptual understanding. Several factors contribute to this issue, including students' low visual representation skills, lack of experience in connecting real-world contexts with mathematical models, and limited abstract thinking abilities. As stated by Ningsih, Mulyadi, and Lestari (2021), some students only perceive the context as a story without relating it to the relevant mathematical concept. Furthermore, according to Hidayat, Pratiwi, and Mulyono (2020) students who are not yet familiar with mathematical modeling activities tend to struggle in identifying patterns and translating contextual information into arithmetic sequences. Therefore, in addition to presenting relevant contexts, teachers must also consider other pedagogical strategies, such as the use of visual media, cooperative learning, and conceptual reflection to reinforce the connection between context and formal mathematical concepts.

ALT reflects outcomes from implementing the hypothetical learning trajectory (HLT) during real classroom learning (Qomari, Lestari, & Fauziyah, 2022). Comparing HLT with ALT reveals students' actual learning paths (Firdaus, Nuryani, & Fitriani, 2020). This process evaluates how well students grasp the concepts and meet learning goals. Ultimately, the comparison highlights how empirical data and hypothesis-driven design shape educational theory (Fauziyah, 2023).

The HLT implementation results show that its PMRI-based design enables students to discover the concept of equivalent fractions and supports their understanding through tailored, engaging activities (Adelia, Putri, Zulkardi, & Mulyono, 2022). Grouping students by learning style improves comprehension and retention. Students also build a solid understanding of the circumference of flat shapes like polygons, squares, and rectangles. The actual classroom learning aligns well with the intended learning goals (Qomari, Lestari, & Fauziyah, 2022).

Consistent with previous research (Fauzan, Zulkardi, & Putri, 2020), this study used retrospective analysis to develop ALT (Qomari, Lestari, & Fauziyah, 2022). The resulting LIT shows that student activity sheets based on realistic mathematics education enhance students' contextual and conceptual understanding. This approach fosters more interactive, relevant learning, increasing student motivation and engagement (Baharuddin, Abrar, Nur, & Angriani, 2024). The study concludes that the learning design supports students in problem-solving and strengthens their conceptual abilities (Dwiputri, Rusliah, & Deswita, 2023).

CONCLUSION

Based on the results and discussion of the research, it can be concluded that the hypothetical learning trajectory (HLT) effectively guided students from real-life problems toward understanding abstract mathematical concepts. Through pilot and teaching experiments, the HLT was refined based on student feedback, helping them visualize number patterns, identify arithmetic sequences, and formulate the nth term. The comparison between HLT and actual learning trajectory (ALT) showed that the intended learning goals were largely achieved, though some low-ability students continued to struggle with contextual problem interpretation. This underscores the need for teacher scaffolding to support guided reinvention as emphasized in PMRI. Overall, the

Musi 6 Bridge context enriched students' conceptual understanding and contributed to the development of a local instructional theory (LIT) that teachers can adopt to create more meaningful and effective learning experiences.

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