Local Instructional Theory: Social Arithmetic Learning Using The Context Of The Monopoly Game

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Abstrak

Rendahnya kemampuan literasi matematis siswa sangatlah berpengaruh pada hasil belajar siswa pada topik aritmetika sosial. Hal ini juga dikarenakan kurangnya desain pembelajaran yang berorintasi pada permasalahan kehidupan sehari-hari siswa. Tujuan penelitian ini adalah untuk meneliti lintasan belajar siswa dalam pembelajaran aritmatika sosial melalui Hypothetical Learning Trajectory (HLT) yang didesain dengan menggunakan pendekatan Pendidikan Matematika Realistik Indonesia (PMRI) konteks permainan monopoli. Penelitian dilaksanakan di SMP Negeri 1 Tomohon pada kelas VII E sebagai kelas pilot experiment dan kelas VII F sebagai kelas teaching experiment. Penelitian ini menggunakan metode penelitian design research yang terdiri dari 3 tahap pelaksanaan yaitu merancang aktivitas pembelajaran (preliminary design), melaksanakan pembelajaran (teaching experiment) dan melakukan analisis retrosepektif (retrospective analysis). Teknik pengumpulan data dilakukan dengan observasi, dokumentasi dan video, data tertulis dan juga wawancara. Kemudian HLT yang didesain dibandingkan dengan kegiatan siswa yang sebenarnya terjadi di dalam kelas saat proses pembelajaran berlangsung, sehingga di tahap analisis retrospektif didapatkan lintasan belajar siswa akhir dari HLT ke Local Instruction Theory (LIT). Hasil penelitian menyimpulkan bahwa lintasan belajar yang telah didesain dari kegiatan pembelajaran di kelas menggunakan konteks permainan monopoli dapat membantu siswa dalam menyelesaikan permasalahan aritmatika sosial pada level formal dengan menggunakan pengetahuan dan pengalaman mereka di level situsional, referensial dan general.

Kata Kunci: Teori Pembelajaran Lokal, Aritmatika Sosial, Permainan Monopoli, PMRI

Abstract

The low level of students' mathematical literacy skills greatly influences learning outcomes on social arithmetic. This is also due to the need for learning design for students' daily life problems. This study aimed to examine student learning trajectories in social arithmetic learning through the Hypothetical Learning Trajectory (HLT), designed using the Indonesian Realistic Mathematics Education (PMRI) approach in the monopoly game context. The research was conducted at SMP Negeri 1 Tomohon in class VII E as a pilot experiment class and class VII F as a teaching experiment class. This study uses the design research method, which consists of 3 stages of implementation, namely designing learning activities (preliminary design), carrying out learning (teaching experiments), and conducting retrospective analysis (retrospective analysis). Data collection techniques used observation, documentation video, written data, and interviews. Then, the designed HLT is compared with student activities in the classroom during the learning process. In the retrospective analysis stage, the final student learning trajectory is obtained from HLT to Local Instruction Theory (LIT). The study results concluded that the learning trajectory designed from classroom learning activities using the Monopoly game context could help students solve social arithmetic problems at the formal level by using their knowledge and experience at the situational, referential, and general levels.

Keyword: *Local Instructional Theory*, *Social Arithmetic*, *Monopoly Game*, *PMRI*

INTRODUCTION

Social arithmetic is the most frequently applied mathematical material in everyday life. For example, in buying and selling (commerce) activities which students have certainly experienced. In this activity,

students often face problems finding the buying price, selling price, loss, or profit they make. However, there are still many students who have not mastered this material, especially if it is in the form of story questions (Mukrimatin et al., 2018; Agnesti & Amelia, 2021; Mahmuda et al., 2021). Students find it challenging to understand the meaning and translate story problems into mathematical form (Rahmania & Rahmawati, 2016; Dwidarti et al., 2019; Bahir & Mampouw, 2020). Apart from that, in solving social arithmetic questions, students experience problems because they have not mastered the prerequisite material for social arithmetic, namely the arithmetic operations of multiplication and division (Setyono & Sutarni, 2013; Luthfia & Zanthy, 2019; Epran et al., 2022).

After conducting observations and interviews with teachers at SMP Negeri 1 Tomohon, it turned out that social arithmetic learning is usually learned from direct explanations by teachers, and students work on questions from textbooks provided by the school so that students are not too active and participate in learning activities. Students are also embarrassed to ask questions, making it difficult for teachers to confirm whether they have understood or understood the material presented.

In overcoming the problems above, teachers are not only teachers but also educators and facilitators to enable students' learning process. This is closely related to how teachers carry out learning in class. So, we need exciting and meaningful learning for students so that they become more motivated to learn.

On every occasion, mathematics learning should start with introducing a problem appropriate to the situation (contextual problem). Using context will bring students toward understanding of mathematics from something real for students to something formal that can be written with symbols through the mathematization stage (Utari, 2017; Nolaputra et al., 2018; Aghnia, 2021). The use of context in learning is closely related to the Indonesian Realistic Mathematics Education (PMRI) approach (Pebriana, 2017; Ulya et al., 2019; Purba, 2022). Freudenthal (Mangelep, 2017) revealed that PMRI is very beneficial because (1) it can make mathematics more engaging, relevant, and meaningful, not too formal and not too abstract, (2) it can take into account the level of students' abilities, (3) it emphasizes learning mathematics in "learning by doing," (4) can facilitate standard solutions (algorithms), (5) uses context as a starting point for learning mathematics.

A challenge is classified as "realistic" when it can be conceptualized and is perceived as genuine within the cognitive processes of students. According to Wijaya (2012), a realistic problem can be presented through several mediums such as a fictional narrative, a gaming scenario, or even a formal mathematical framework. In this case, the researcher chose to use games that students often use or play as a starting point. Research conducted by Dina (2014) concluded that using a context in games can help students learn to interpret mathematics and the relationship between mathematics in everyday life, understand mathematical concepts, and be more motivated in learning.

The game used in this research is something new for teachers and students. Because learning with a game context has never been developed and implemented at SMP Negeri 1 Tomohon. In this research, researchers used the Monopoly game. According to Husna (Suprapto, 2013), the Monopoly game is one of the world's most famous board and group games. The goal of this game is to control all plots through the process of renting, selling, and buying, with simple economic principles. The rules or procedures for playing Monopoly are familiar to students, so using it in learning is very good because it is not too difficult, and they already know the game. Apart from that, with this monopoly game, students can recognize and learn several basic concepts related to social arithmetic material, such as value per unit, overall value, selling price, buying price, profit, and loss.

Based on the study above, this research aims to examine students' learning trajectories in learning social arithmetic through the Hypothetical Learning Trajectory (HLT), which was designed using the Indonesian Realistic Mathematics Education (PMRI) approach in the context of the monopoly game.

METHODS

The research employed a design research methodology. According to Gravemeijer and Van Eerde (Prahmana, 2017), design research is a study methodology that seeks to cultivate Local Instruction Theory (LIT) through the collaborative efforts of researchers and educators, with the goal of enhancing the overall quality of learning experiences. The study progressed through three distinct stages, namely preliminary design, experimental design, and retrospective analysis, as in the following figure 1:

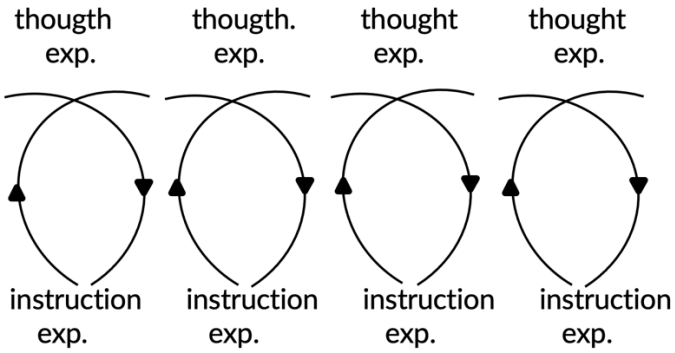


Figure 1. Cyclic process in design research

The subjects in this research were 40 students in class 7E of SMP Negeri 1 Tomohon. The data in this research was collected through video recordings, documentation, written data and observation. Meanwhile, data analysis techniques use HLT validity tests, Trackability, Data Triangulation, and Cross Interpretation.

RESULT AND DISCUSSION

Preliminary Design

At this stage, the researcher designed the initial idea of using the Monopoly game as a context for learning social arithmetic. Previously, the researcher reviewed the literature, made observations at SMP Negeri 1 Tomohon, and finally compiled the Hypothetical Learning Trajectory (HLT). HLT or learning trajectory estimates (thinking processes) are anticipations of what might happen to students who receive mathematics learning materials. According to Gravemeijer (Prahmana, 2017: 20), the concept of HLT encompasses three primary elements. These elements include the learning objectives of mathematics, the learning activities employed, and the devices or media utilized during the instructional process. Additionally, HLT involves the conjecture of the learning process, which aims to ascertain students' comprehension and the strategies that arise and evolve because of classroom learning activities.

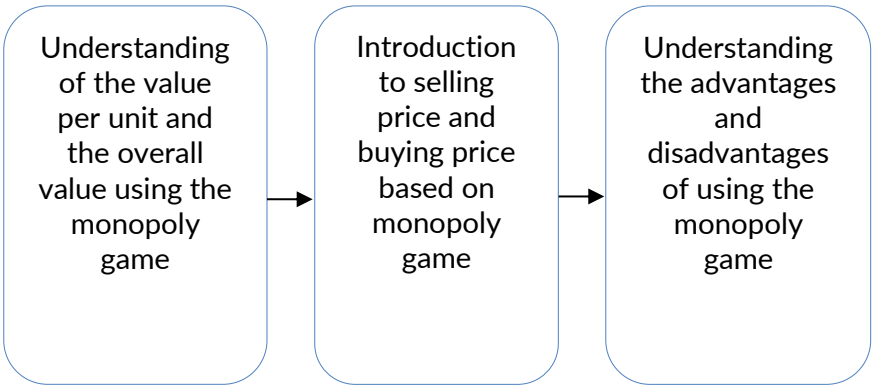


Figure 2. Learning Trajectory for Social Arithmetic Learning

Design Experiment

a. Pilot Experiment

At this stage, the researcher tested the previously designed HLT in class 7E of SMP Negeri 1 Tomohon with 3 activities. These activities include playing Monopoly as a starting point for learning value per unit and overall value, recording purchases and sales using the Monopoly game, and playing designated Monopoly. Based on the pilot experiment results and discussions with teachers who teach in class, several things can be concluded related to students' alleged learning trajectories. First, the Monopoly game can be used as a medium to help social arithmetic learning activities because students can be directly involved in activities related to discovering the concept of social arithmetic. Second, in the first activity, namely playing Monopoly as a starting point for learning the value per unit and overall value, the teacher needs to explain a little about the worksheet that students will work on so that they have the same rules in solving the problems given.

Furthermore, another conclusion obtained is that in the third activity, namely playing Monopoly, which has been determined, apart from the teacher explaining the rules of the game which have been determined in front of the class, the worksheet needs to provide these rules so that students can reread them when they forget. This is useful for making students able to solve problems according to the time allotted. Third, the time allotted for each activity to play needs to be adjusted to the student's knowledge.

b. Teaching Experiment

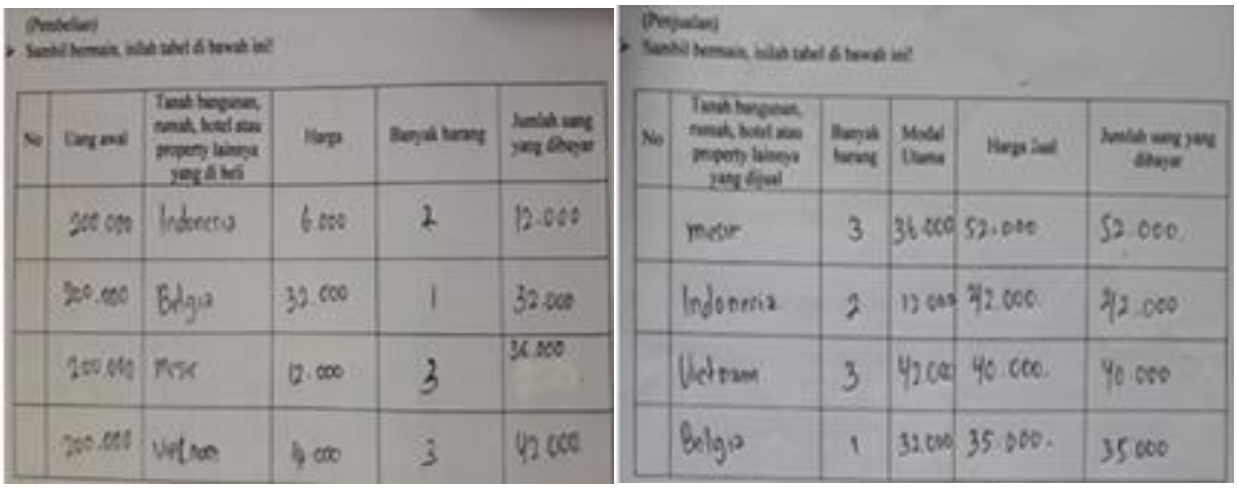
The Teaching Experiment was conducted in class VII F with 40 students divided into 8 groups, consisting of 3 activities, and completed in 3 meetings.

Activity 1. Activity playing Monopoly as a starting point for learning the value per unit and the overall value.

Figure 3. Students playing monopoly.

Students play a Monopoly game freely with their partners. Next, they solve situational problems related to the game activity. This activity aims to determine students' ability to identify social arithmetic processes in the game, with the hope that students' knowledge will emerge in determining the overall value and value per unit. The conclusion given by the students is from the monopoly game to find the total house price obtained by multiplying the price to buy 1 house by the number of houses that can be bought. Finally, the teacher guides students to unite the perception of the purchase price of 1 house into the value per unit and the total price of the house into the overall value.

Activity 2. Record purchases and sales using the Monopoly game.



No	Uang awal	Tanah bangunan, rumah, hotel atau property lainnya yang di beli	Harga	Banyak barang	Jumlah uang yang dibayar
	200.000	Indonesia	6.000	2	12.000
	200.000	Belgia	32.000	1	32.000
	200.000	Mesir	12.000	3	36.000
	200.000	Vietnam	4.000	3	12.000

No	Tanah bangunan, rumah, hotel atau property lainnya yang dijual	Banyak barang	Modal Utama	Harga Jual	Jumlah uang yang dibayar
	mesir	3	36.000	52.000	52.000
	Indonesia	2	12.000	92.000	92.000
	Vietnam	3	12.000	40.000	40.000
	Belgia	1	32.000	35.000	35.000

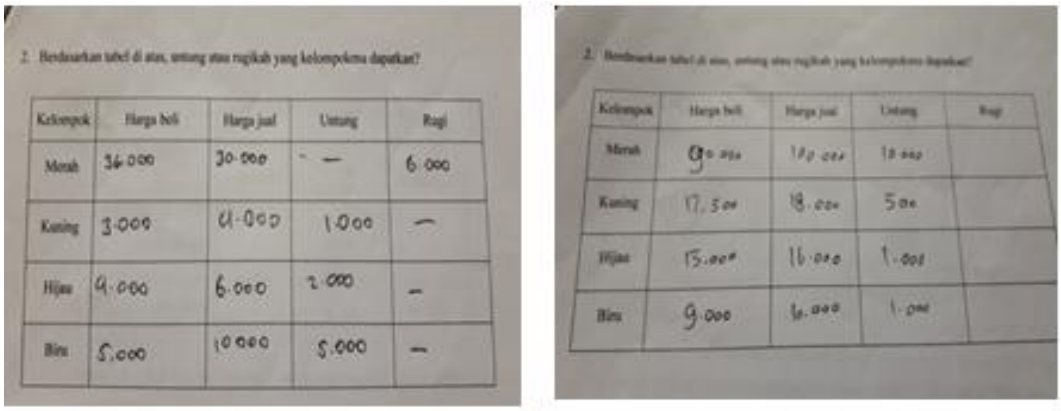
Figure 4. Students record purchasing and sales activities.

In this activity, students play the Monopoly game while recording and completing several questions on the worksheet related to the purchases and sales that students make while playing. Students still use the Monopoly game context as a learning medium at this stage, as in previous activities. This activity aims to guide students to know and understand the meaning of selling price and buying price by linking previous game activities and the understanding they already have.

Activity 3. Play Monopoly set.

Figure 5. Students playing Monopoly set.

In this activity, students carry out a modified (defined) Monopoly game simulation, which focuses on advantages and disadvantages based on situational problems in the Monopoly game. Then, they solve the problems given in the LKS based on the game they simulated initially. At this stage, students work towards the formal stage of determining advantages and disadvantages. This activity aims to introduce the concept of profit and loss based on the Monopoly game, which has slightly modified the game's rules. Namely, each group plays Monopoly with 4 rounds, where the researcher has determined that if the group gets an opportunity card and a general fund card, then the group has the right to buy land. The building, house, or hotel he chooses in a country, and if it stops at a port, tax, company, station, or bridge, the group has the right to take the opportunity to roll the dice again.



Kelompok	Harga beli	Harga jual	Untung	Rugi
Merah	36.000	30.000	-	6.000
Kuning	3.000	4.000	1.000	-
Hijau	9.000	6.000	2.000	-
Biru	5.000	10.000	5.000	-

Figure 6. Student answers to the worksheet provided.

c. Retrospective Analysis

At this stage, the HLT that has been previously designed is then compared with student events that occur in the classroom so that it can answer the research questions, namely (1) What is the role of the monopoly game in helping students' understanding of the concept of Social Arithmetic in class VII SMP N 1 Tomohon? Moreover, (2) How can students' learning trajectories in Social Arithmetic based on the PMRI approach using monopoly games in class VII of SMP N 1 Tomohon develop from the informal to the formal stage?

The Monopoly game holds significance in facilitating students' acquisition of social arithmetic skills and fostering an enhanced sense of motivation towards studying. This phenomenon is seen in the demeanor of students who demonstrate attentiveness and enthusiasm in their engagement with educational pursuits. The utilization of the Monopoly game framework in educational settings motivates students to engage in the exploration and application of diverse solutions in order to solve arithmetic issues with social relevance. The utilization of the monopoly game within an educational setting has the potential to enhance students'

comprehension of fundamental concepts such as unit value, total value, acquisition cost, selling price, profitability, and financial loss.

Value Per Unit and Value Overall

Students play Monopoly freely with a set time at the situational stage in learning value per unit and overall value. The learning trajectory is obtained from this stage: playing Monopoly freely with their group mates.

Figure 7. Situational Stage of Learning Per Unit Value and Overall Value

Students' achievement at the referential level in this activity is indicated by the ability of students to answer the problems in the LKS based on the previously carried out games. There are two learning trajectories. The first is that students can fill in the table as expected by choosing one country and one house/hotel purchased based on the purchasing activities carried out, while for the second, students are still not properly filling in the table as expected, namely writing all the countries and houses/hotels he bought. This second learning trajectory needs guidance from the teacher so that students have the same perception or rules in filling out the table so that students will be able to answer the problems in the third column or the calculation process.

Figure 8. Referential Learning Stage Per Unit Value and Overall Value

Furthermore, the method or strategy students choose is using arithmetic operations to determine the total house price they pay at the general level (model-for). At this stage, the first learning trajectory, namely, students use the concept of multiplication operations by multiplying the price to buy 1 house by the number of houses that can be purchased. Meanwhile, in the second learning track, students use the addition operation by adding the price of 1 house as much as the house they bought. During class discussions, the teacher guides students to use multiplication operations in solving problems so that students have the same perception later in concluding.

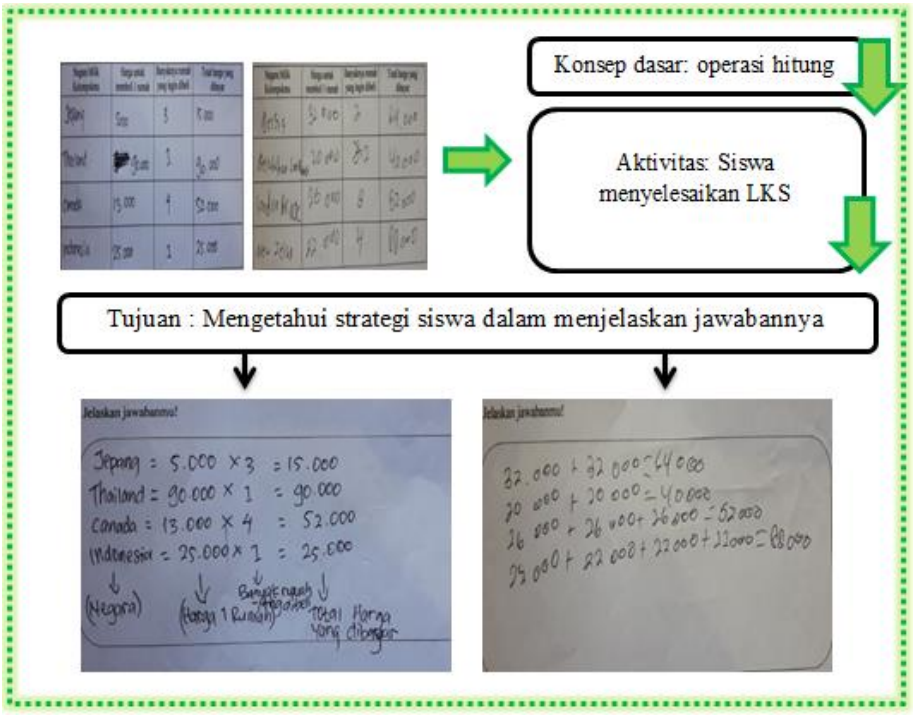


Figure 9. General Stage of Learning Per Unit Value and Overall Value

Student achievement in the formal stage is shown from the results of student answers leading to the conclusion of determining the value per unit and the overall value, namely the correct solution to the problem of the value per unit and the overall value using a formal formula.

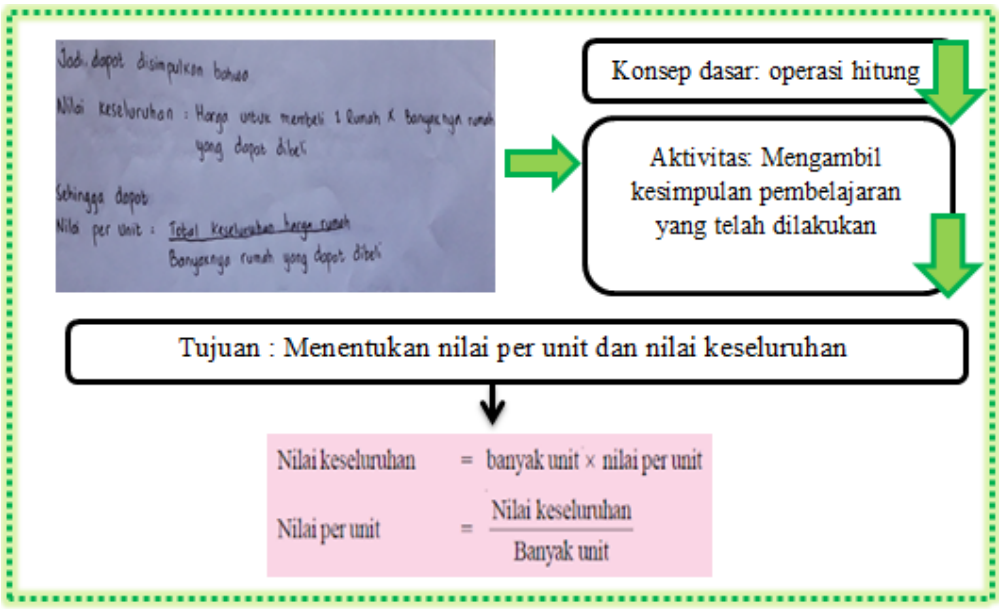


Figure 10. The Formal Stage of Learning Values Per Unit and Overall Value

Profit and loss

In activities to guide students in discovering the concept of profit and loss, the researcher designs a monopoly game with a few modifications or has set some of the game's rules, such as no longer they are using opportunity cards and general fund cards so that the game is more focused on buying and selling activities carried out by students. First, the situational stage, the beginning of the informal stage in this activity, is carried out by students using the context of the Monopoly game. Here, students play Monopoly, which has set the game's rules.

Figure 11. Situational Stage of Profit and Loss Learning

Meanwhile, the referential stage is demonstrated by the student's ability to answer the problems given on the LKS. Learning trajectories are obtained when students record buying and selling activities in various ways. First, they write down several houses in the country belonging to the group they are buying, but in the

sales price column, they choose one of several countries to sell. Second, students only chose to write down one house in the country belonging to the group they purchased. From several varied student answers, students are familiar with selling and buying prices from previous activities.

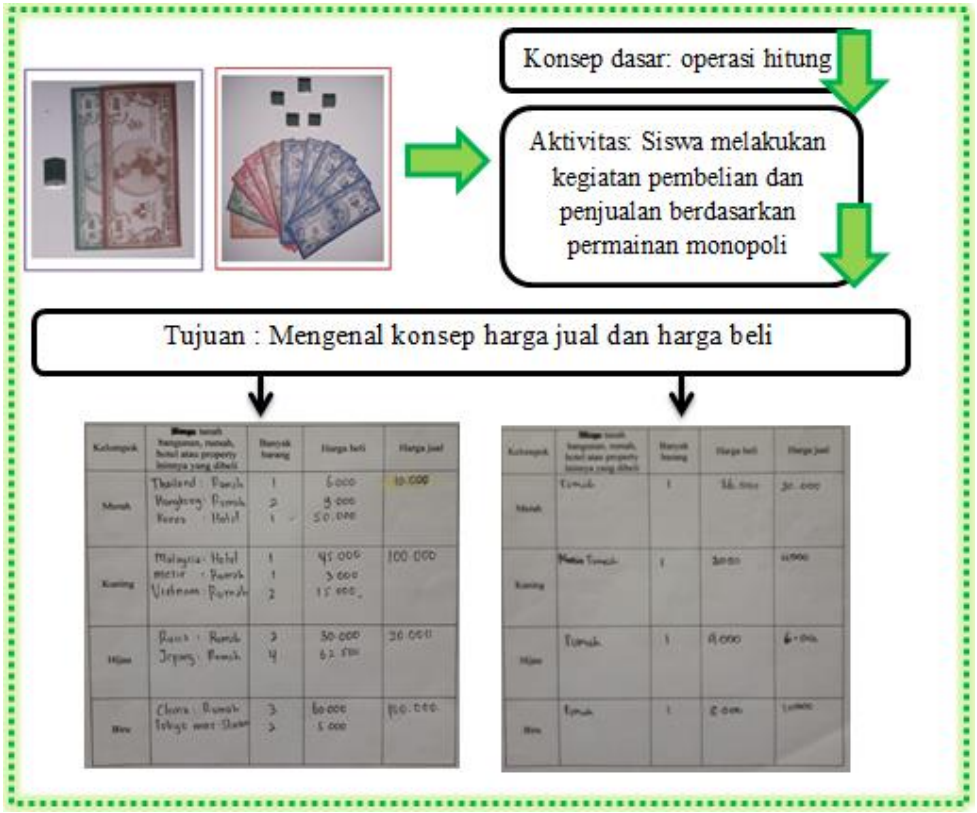


Figure 12. Profit and Loss Learning Referential Stage

The results of student work in identifying profit or loss based on the Monopoly game show student achievement for the general stage. There are two learning tracks. Students can identify profits and losses from buying and selling activities for the first learning track. From the students' varied answers, some make a profit, a loss, and both profit and loss by paying attention to the relationship between the selling price and the buying price, following Bito (2016), who states that at the general stage, the model developed by students has led to the search for mathematical solutions which are called models for problem-solving. Secondly, students have yet to be able to identify profit and loss. From the students' answers, they fill in the profit column with the selling price and the loss column with the buying price. The teacher directs and guides the group with the second learning trajectory.

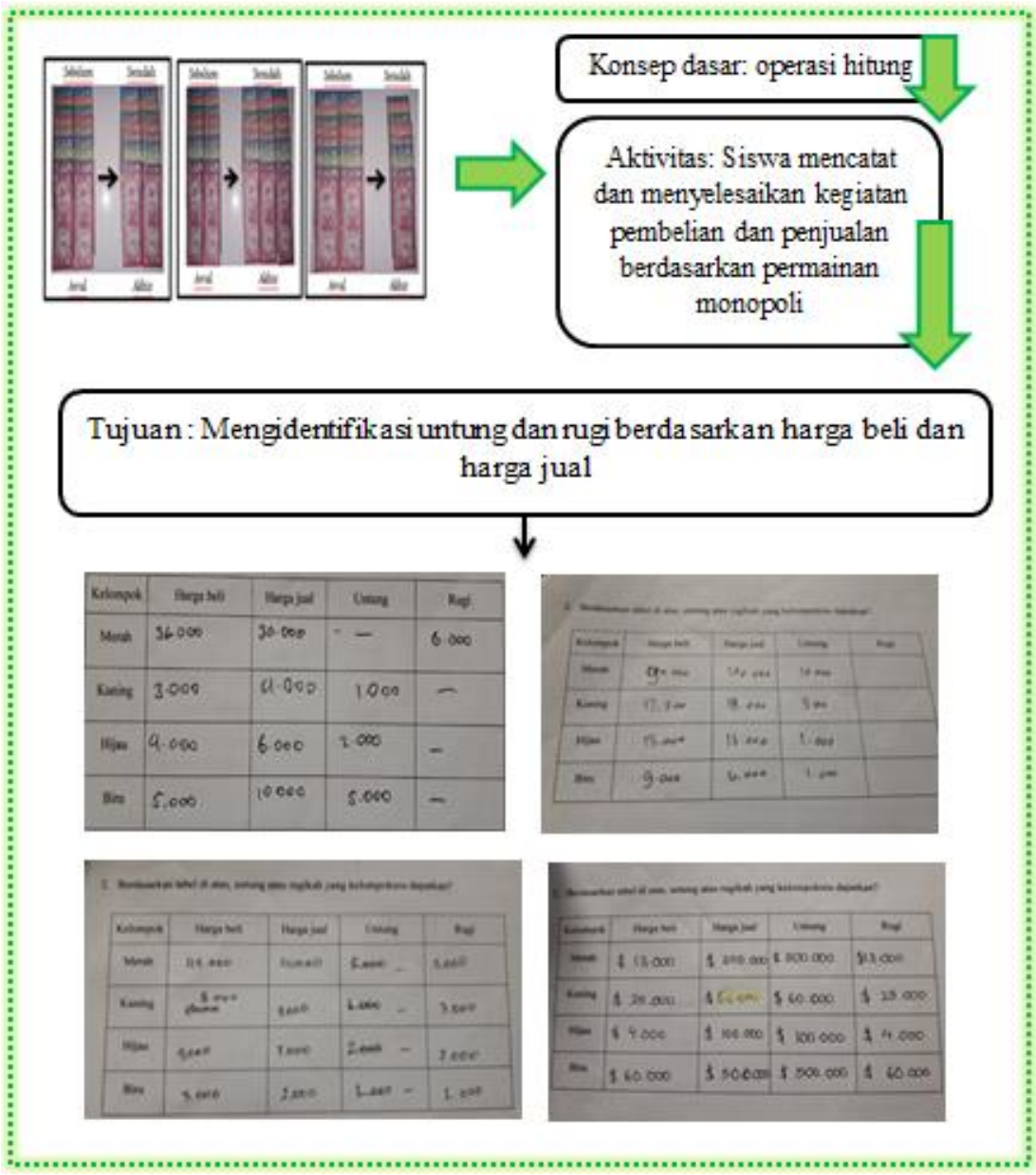


Figure 13. General Stages of Profit and Loss Learning

Furthermore, when students can use symbols or formal formulas to find the profit and loss from buying and selling activities, this shows the formal stage that the students have. Students can answer questions about profit and loss using symbols or formulas at this stage.

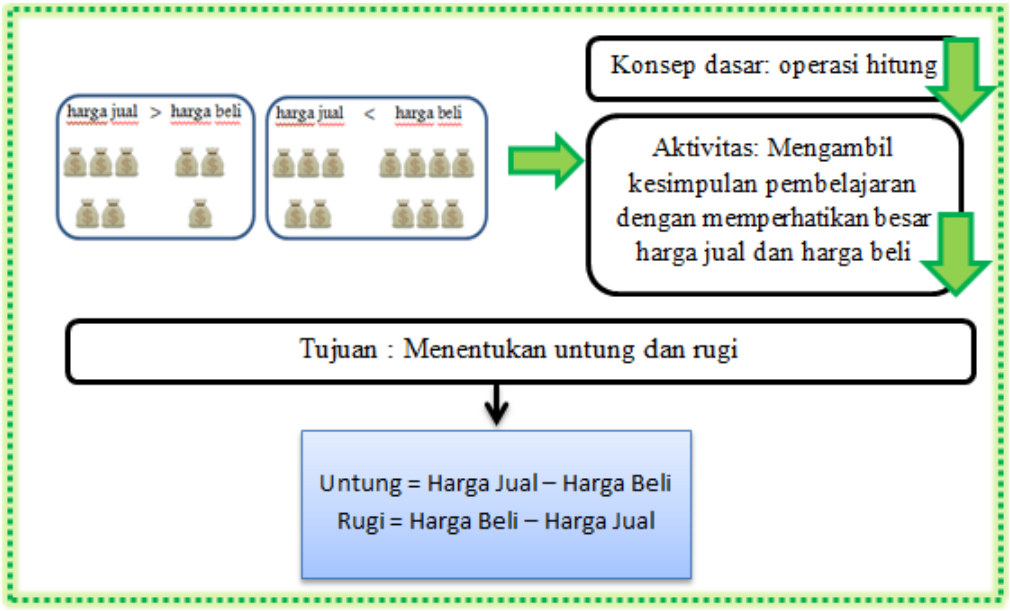


Figure 14. The Formal Stage of Profit and Loss Learning

Furthermore, students can find out the relationship between selling price, buying price, profit, and loss more easily after completing the monopoly playing activity determined for previous profit and loss learning.

CONCLUSION

Based on the research results and discussions that have been described, it can be concluded that: (1) The use of the Monopoly game framework in the design of social arithmetic learning holds significant value as an initial catalyst and enhancer of student motivation within the realm of social arithmetic education. The incorporation of the Monopoly game environment inside the classroom learning process facilitates students' engagement with social arithmetic concepts, leading to their reinvention and enhanced understanding. The incorporation of the Monopoly game into educational settings provides students with an opportunity to engage in active learning experiences, so enabling them to investigate and employ many tactics to solve social arithmetic problems. The actions of purchasing and selling houses or property entail a strategic approach that enables students to explore the notion of unit value, total worth, purchase price, selling price, profit, and loss. The understanding of this idea is essential for the acquisition of social arithmetic skills at the junior high school level. (2) The learning trajectory of students in social arithmetic learning that is generated is the learning trajectory that students go through starting from playing Monopoly as an experience-based activity, which can provide a social arithmetic learning process, starting from the value per unit, the overall value, the purchase price, the selling price, to the formal form of profit and loss. Students play Monopoly freely with a set time at the situational stage in learning value per unit and overall value. Students' achievement at the referential level in this activity is shown by the ability of students to answer the problems in the LKS based on discussions and games previously carried out. Furthermore, the method or strategy students choose is using arithmetic operations to determine the total house price they pay at the general level (model-for). Student achievement in the formal stage is shown from the results of student answers, which lead to determining the value per unit and the overall value. Meanwhile, students play Monopoly with predetermined rules at the situational stage in learning profit and loss. Then, at the referential level, using agreed buying and selling prices (model of) becomes a student strategy to simplify calculations and find the concept of profit and loss. Furthermore, the relationship between buying and selling prices before and after the game is used as a model at the general formal level to solve social arithmetic problems. After achieving some basic concepts of social arithmetic, students can solve problems at the formal level by using their knowledge and experience at the situational, referential, and general levels. Of all the activities students go through, researchers can state that students can understand the basic concepts of social arithmetic based on a learning trajectory designed with the Monopoly game starting point.

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