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Didactic Design Of Social Arithmetic Through Generative Learning Model To Develop The Mathematic Representation Disposition Of Students

Nurwinda Apriyani [1], Dwi Pulsha Apriliande[2], Asmadewi[3]
[1,2,3] IAI An Nur Lampung, Lampung
Email: apriyani.nurwinda@gmail.com[1]
dwipulshawin1@gmail.com[2], asmadewibaby@gmail.com[3]

Abstrak

Penelitian ini bertujuan untuk mendapatkan produk desain didaktis aritmetika sosial yang dikembangkan melalui model pembelajaran generatif serta mengembangkan disposisi representasi matematis peserta didik dengan penerapan desain didaktis aritmetika sosial melalui model pembelajaran generatif. Penelitian ini mengacu pada prosedur penelitian dan pengembangan oleh *Borg and Gall* yaitu Penelitian dan pengumpulan data, perencanaan dan pengembangan produk, validasi, revisi-revisi dan uji lapangan. Hasil validasi ahli menyatakan desain didaktis valid dan layak untuk diteliti lebih lanjut. Hasil uji lapangan menunjukkan bahwa nilai kemampuan representasi yang tinggi diimbangi nilai disposisi representasi matematis yang tinggi pula. Desain didaktis empirik yang telah diperoleh terbuka untuk terus disempurnakan melalui tahapan pengembangan analisis situasi didaktis, metapedadidaktis dan retrosfektif kembali

Kata Kunci: *desain didaktis, kemampuan dan disposisi representasi matematis*.

Abstract

This study aims to obtain the didactic design product of social arithmetic developed through the generative learning and developing disposition of mathematical representation of learners with the application of didactic design of social arithmetic through generative learning. This research refers to Borg and Gall's research and development procedure. They were Research and information collection, planning and developing of product, validation, revisions and field tests. Expert validation results suggest that didactic design was valid and feasible for further investigation. Field test results show that high representation values were balanced by high mathematical representation disposition values. Empirical didactic design that have been obtained were open to continuous improvement through the development stage of didactic situational analysis, metapedadidactic and retrospective again

Keywords: *didactic design, ability and disposition of mathematical representation*

INTRODUCTION

The development of science and technology requires humans to continue to improve their quality and abilities. Efforts to master science and technology cannot be separated from the role of education. The National Council of Teachers of Mathematics (NCTM, 2000) states that learning mathematics in schools from primary to higher education requires learning standards that function to produce students who have the ability to think, mathematical reasoning ability, have useful basic knowledge and skills. The learning standards include content standards and process standards.

The teacher's thinking process in the context of learning occurs in three phases, namely before learning, during learning, and after learning. The tendency of the thought process before learning that is more oriented to the translation of objectives has an impact on the process of preparing teaching materials and the lack of anticipation, especially those that are didactic. In addition, the learning process of mathematics which tends to be directed at imitative thinking, has an impact on the lack of didactic anticipation which is reflected in the preparation made by the teacher. One of the teacher's efforts to improve the quality of learning is through reflection on the relationship between the design and the learning process that has been carried out.

The practice of learning mathematics at SMPN 1 Abung Tinggi uses direct learning with the teacher actively being the center of the activity while students are learning in a passive condition. This passive class condition is inversely proportional to the enthusiasm shown by students to study with discipline even though the average distance between home and school is more than 3 kilometers by foot. Graue and Walsh (in Claxton, 2004) say that a person's behavioral tendencies are formed based on local characteristics. The form of local Lampung characteristics attached to students contains the cultural values of Piil Pesenggiri. According to Syani (2010) Piil Pesenggiri is self-esteem related to feelings of competence and personal value or is a combination of trust and self-respect. Therefore, students who have Piil Pesenggiri have feelings of confidence, responsibility, competence and are able to overcome the problems given. Learning in schools will be more meaningful if teachers can connect the character of students with the learning experience provided.

In the material analysis carried out, the teacher at the school stated that not all mathematics material was difficult, such as social arithmetic material, including easy material, because it contained everyday life events. However, the students showed different things. The lack of mathematical representation of social arithmetic material is shown in the results of working on the problem. However, there are psychological aspects that contribute to a person's success in completing tasks well. The psychological aspect is the disposition of thinking. Tishman (2014) defines thinking disposition as a tendency to think in a certain way under certain circumstances. Furthermore, Tishman (2014) states that individuals must form good habits to use certain abilities, or think and choose to use the abilities they have. The habit of students is based on local wisdom that contains the cultural values of Piil Pesenggiri which have been described previously. Furthermore, in the learning process, when the measurement of representation ability is carried out, it can also be seen that the disposition of thinking that arises is then called the disposition of mathematical representation.

After looking at the students and the material, this will be a reference in preparing the learning design. Suryadi (2010) said that the preparation of the right learning design has an important role in achieving learning objectives. Lesson plans that do not take diversity into account students' responses to the developed didactic situations so that the series of didactic situations developed are likely no longer in accordance with the diversity of the learning trajectories of each student. Students' responses to didactic situations that are developed beyond the reach of the teacher's thinking or are not explored so that the various learning difficulties that arise are not responded to by the teacher. In accordance with the opinion of Suryadi (2010), the lack of didactic anticipation that is reflected in learning planning, can have an impact on the less optimal learning process for each student. Students' responses to didactic situations that are not accommodated cause learning difficulties to not be responded to appropriately.

In practice, students naturally experience a situation called a learning obstacle. According to Brousseau (2009) there are three contributing factors, namely ontogeny (mental readiness to learn), didactic (due to teacher teaching), and epistemological (student knowledge that has a limited application context). The learning design is based on the learning obstacles experienced by students as an alternative in overcoming the obstacles faced. Efforts that need to be made by teachers are to develop learning plans as a first step before learning. The didactic design is designed by considering the student's line of thought (learning trajectory) that will develop during learning and needs to be prepared to anticipate what will be done, thus the learning process that takes place does not ignore the diverse thoughts of students. The teaching and learning process, which is still seen as a process of transferring knowledge, is verbalistic in nature and needs to be changed. Teachers must encourage the development of students' understanding of mathematics so that curiosity grows and is able to make representations about the results of solving mathematical problems that have been done by students.

Another effort to develop the disposition of mathematical representations in learning mathematics is that teachers must strive for learning by using learning models that can provide opportunities and encourage students to develop dispositions of mathematical representations in learning. Therefore, one of the learning models that can provide space for students to develop their representational abilities is the generative learning model. The generative learning model is based on the constructivism view, with the basic assumption that knowledge is built in the minds of the students themselves. This is emphasized by Osborn and Wittrock (1993) that the essence of generative learning is that the brain does not receive information passively, but instead actively constructs an interpretation of the information and then draws conclusions. The generative learning model is one of the learning models carried out with the aim that students actively construct knowledge in learning independently or in groups. The generative learning stage consists of four stages, namely exploration, focusing, challenge and application. In the generative learning model, students are given the widest opportunity to express ideas, opinions, or criticize the answers of their friends. Students are encouraged to be more active in communicating and discussing to construct a concept to be achieved in learning. Students who have been left in passive learning conditions deserve to be given learning through generative learning models. In line with this, the ability and disposition of students' mathematical representations can be developed and the disposition of mathematical representations is expected to appear at every step in the generative learning model. Based on this explanation, the purpose of this research is to obtain a social arithmetic didactic design product developed through a generative learning model and to develop the ability and disposition of students' mathematical representations by applying social arithmetic didactic design through a generative learning model.

METHODS

The research method used is the Research and Development (R&D) method. The research and development steps carried out refer to the steps developed by Borg & Gall (1989), with details as follows:

1. Research and data collection.
2. Product Planning and Development Steps
3. Validation and Field Test

The validation steps and field tests carried out include:

a. Expert validation
b. Product revision step I
c. Initial Field Test
d. Product revision step II
e. Field trial
f. Product revision step III

Observational data on the disposition of mathematical representations are obtained through observations and provide checklists/points. If the observed students perform one of the indicators in the observation sheet. From each meeting, the percentage of these points is calculated to see the disposition of the mathematical representation of students. The average percentage of each meeting and the average of each indicator can be calculated using the following formula:

$$P = \frac{Jumlah\ skor\ yang\ diperoleh}{Jumlah\ skor\ seluruh\ item} \times 100\ \%$$

The percentage of values obtained during the study can be used as a reference for the development of the emergence of the disposition of mathematical representations in the learning process, so that it can be used as a correction to carry out the next lesson.

RESULTS AND DISCUSSION

Based on the steps of development research referring to the steps developed by Borg & Gall (1989), the results obtained in the first step, namely research and data collection, a preliminary study was carried out on learning social arithmetic material. Through observations and data results as well as needs analysis, a social arithmetic didactic design was chosen through a generative learning model. Product The didactic design is made based on the analysis of didactic, metapedadidactic and retrosfectic situations so as to produce a hypothetical didactic design. Furthermore, the product was validated by experts who concluded that the didactic design was valid and worthy of further research. Therefore, the research can be continued in the initial field test step.

In the initial field test step, no significant revision was carried out. This is because the didactic and pedagogical anticipations described are in accordance with the responses shown by students. Then proceed to the field test step in a different class. The application of the didactic design of social arithmetic through the generative learning model showed interesting findings, namely the high value of students' representational abilities balanced by the high value of disposition of mathematical representation as well.

This research takes 8 hours of lessons, 7 hours of lessons. Previously, the class setting was formed by U and students were given name-tags to facilitate observation and mobility so that students could be accessed more evenly. This situation also facilitates students in learning activities individually or in groups. Observations on the disposition of mathematical representations were carried out on eight students with high, medium and low abilities. Researchers use codes to indicate the names of students, namely; R1, R2, R3, R4, R5, R6, R7 and R8.

The process of developing a didactic situation, analysis of learning situations that occur in response to the developed didactic situation, and decisions made by the teacher during the learning process are described as Didactic and Pedagogical Anticipation (ADP). Arithmetic material in the didactic design of social arithmetic through generative learning models is presented in 3 parts of the material, starting with gross, net and tare material. Then the material gains, losses, discounts and taxes and the last material is single interest.

Related to the created didactic situation. First, the aspect of clarity of the problem is seen from the presentation model and the relationship with the concepts being taught. The problems faced by students are presented with a concrete model by utilizing the scales and the students themselves as objects and an illustrative model in the form of structured tables. Although there are still student responses that are not in accordance with the teacher's predictions, the LKPD used makes the thinking process of students more focused on problems regarding gross, net and tare. This is in accordance with Suryadi's opinion (2010) that the concrete and structured presentation model is quite effective in helping the thinking process of students, so that their response to the given problem appears as expected. Second, the aspect of predicting student responses to each problem presented. Predictions of student responses are presented in learning scenarios which are part of the lesson plan. Anticipation with scaffolding technique is used as an effort to help the thinking process of students. Third, the aspect of the relationship between the didactic situations created in each problem presentation is different. To maintain the consistency of the thought process, the same context is used consistently, namely determining body weight. The relationship between the didactic situations is also related to the concepts introduced, namely gross, net and tare. Fourth, the aspect of developing mathematical intuition. In the illustration of learning, the learning environment that is constructed using real objects is effective in fostering students' mathematical intuition in direct practice.

Informal representations proposed by students based on their mathematical intuition turned out to be the right foundation to direct students' thinking processes to more formal mathematical representations. The developed pedagogical situation always provides opportunities for students to initiate individual learning activities. The tendency of students in seeking truth and curiosity is seen when weighing their weight. The atmosphere was a bit noisy but the focus of the students was on weighing and filling in the data in the given table. The desire to be the first group to finish shows the value of Piil Pesenggiri attached to students. The results of observations during learning related to the achievement of the disposition indicators of the mathematical representation of students are presented in Table 1.

Tabel 2637. Capaian disposisi representasi materi bagian 1

eserta didik	Indikator					
	1	2	3	4	5	6
R1	√	√	-	-	-	√
R2	√	√	√	√	√	√
R3	√	√	√	-	√	√
R4	√	√	√	-	√	√
R5	√	√	-	-	-	√
R6	-	-	-	-	√	-
R7	√	√	√	-	√	√
R8	√	√	-	-	√	√

Table 1 shows the indicators of truth-seeking, open-mindedness and curiosity reaching 87.5%. In these three indicators, only R7 students did not show indicators of truth-seeking, open-mindedness and curiosity. In indicator number 5, self-confidence reaches 75%, with students who do not bring up these indicators are

R1 and R5. In analytical indicators it reaches 50% and the smallest achievement on systematic indicators is 12.5%.

In material 2, after all students have done the apperception task. Learning continues on the core material, namely advantages and disadvantages. The teacher distributes group assignment sheets to each group. The process is further strengthened in presenting the problem of determining the state of an item that is experiencing a gain or loss. Presentation of data with the help of simple tables in the hope that students can focus more on aspects of advantages and disadvantages. Related to the created didactic situation. The clarity aspect of the problem is seen from the presentation model and the relationship with the concepts being taught. A concrete model that is presented by displaying the same item at different prices in several stores. Things as exemplified can occur in the sale of any goods, but the specifics are taken as an example of goods, namely cellphones. Two structured tables are presented and continued to conclude the data. Although there are still student responses that are not in accordance with the teacher's predictions, the task sheets used make the thinking processes of students more focused on problems regarding advantages and disadvantages.

After the students finish working on the task about profits and losses, the teacher gives the next assignment sheet, which is about discounts and taxes. Then a group discussion was conducted. The tendency of students in analytical, truth-seeking and curiosity is seen when expressing the answers. The desire to be in the group with the most correct answers shows the value of Piil Pesenggiri attached to students. Students are then given the opportunity to present the results of their work while the other groups listen. The results of observations during the learning process related to the achievement of the students' mathematical representation disposition indicators are presented in Table 2.

Tabel 2638. Capaian disposisi representasi materi bagian 2

Pesertadidik	Indikator					
	1	2	3	4	5	6
R1	√	√	-	-		√
R2	√	√	√	√	√	√
R3	√	√	√	-	√	√
R4	√	√	√	-	√	√
R5	√	√	-	-		√
R6	√	√	-	-	√	√
R7	√	√	√	-	√	√
R8	√	√	-	-	√	√

Table 2 shows the indicators of truth-seeking, open-mindedness and curiosity reaching 100%. In these three indicators there are changes in R7 students who previously did not bring up indicators of truth-seeking, open-mindedness and curiosity. In indicator number 5, self-confidence reaches 75%, with students who do not bring up these indicators are R1 and R5. In analytical indicators it reaches 50% and the smallest achievement on systematic indicators is 12.5%. The indicators of self-confidence, analytical and systematic have not changed from the previous achievements. Furthermore, at the implementation stage, students work on practice questions as an evaluation at the end of the learning material on advantages, disadvantages, discounts and taxes.

In material 3, after all students have done the apperception task, learning is continued on the core material, namely single flowers and distributing task sheets to each group. The process is further strengthened in the presentation of the problem of determining the amount of interest given by the BANK. At this stage, the actual challenge stage or concept introduction is accepted by students through these activities. Related to the didactic situation created, the aspect of clarity of the problems faced by students is presented with concrete problems with the help of tables. Aspects of the relationship between the created didactic situations used the same context consistently, namely determining single interest. Then a group discussion was conducted. The tendency of an analytical and systematic attitude is seen when starting to work on a given task. The atmosphere became a bit quiet because the focus of students' attention was on solving and filling in the data in the given table. The desire to be the first group to finish and do it correctly shows the value of Piil Pesenggiri attached to students.

Students are given the opportunity to present the results of their work while the other groups listen. Up to this stage the design is still running well. All students can follow the learning process as in the didactic design. The results of observations during learning related to the achievement of the disposition indicators of mathematical representation are presented in Table 3.

Tabel 3. Capaian disposisi representasi materi bagian 3

Pesertadidik	Indikator					
	1	2	3	4	5	6
R1	√	√	√	√	√	√
R2	√	√	√	√	√	√
R3	√	√	√	√	√	√
R4	√	√	√	√	√	√
R5	√	√	√	√	√	√
R6	√	√	√	-	√	√
R7	√	√	√	√	√	√
R8	√	√	√	√	√	√

Table 3 shows the indicators of truth-seeking, open-minded, analytical, self-confidence and curiosity reaching 100%. The systematic indicator reached 87.5% and only R6 did not show this indicator. This achievement shows the development of the representational disposition of students.

Broadly speaking, the situation, response and anticipation carried out can be well received by students. The results of this activity were obtained by Empirical Didactic Design which is possible to continue to be refined. Giving rewards is very important to bring up positive tendencies of students. This is in accordance with the law of consequences proposed by Thorndike (Dahar, 2011) which states that an act accompanied by a pleasant result tends to be maintained and will be repeated next time. Giving rewards or awards by the teacher is a pleasant result for students so that in the next learning students will be more confident to express their opinions.

Disposition indicators of mathematical representation are taken from thinking indicators including; truth-seeking, open-minded, analytical, systematic, self-confident and curious (Nopia, 2016). The following is the disposition of students' mathematical representations that appear at each stage of learning.

1. Exploration

At the exploration stage, the tendency of students to seek truth and curiosity shows their efforts in representing problems based on their experience and knowledge.

2. Focusing

Then the focusing stage where students test hypotheses and explore ideas that lead to open thinking. The tendency of an analytical attitude, and an open attitude is shown through discussions with friends in the group.

3. Challenge

The challenge stage is continued, when students present their findings, an analytical, systematic attitude is built with a sense of self-confidence. When another group expresses the results of their work but feels that the answer is not correct, the other group refutes the arguments presented.

4. Application

Students do the exercises independently. Learners with a represented disposition are shown to be more focused and confident in completing assignments.

It can be concluded that the overall conditions in the learning design provide opportunities for students to develop their mathematical representation disposition. This is in line with the learning theory of behaviorism that changes in behavior as a result of one's own experience in the interaction of students with their environment.

The following is a recapitulation of the achievement of the disposition indicators for the mathematical representation of students, presented in Table 4.

Tabel 4. Pencapaian Indikator disposisi representasi matematis

Indikator Representasi Matematis	Bagian Materi ke-			Rata-rataper Indikator
	1	2	3	
Pencariankebenaran	87,5	100	100	**95,83**
Berpikir terbuka	87,5	100	100	**95,83**
Analitis	50	50	100	**66,67**
Sistematis	12,5	12,5	87,5	**37,5**
Kepercayaan diri	75	75	100	**83,33**
Rasa ingin tahu	87,5	100	100	**95,83**
Rata-rata per Bagian Materi	**66,7**	**72,9**	**97,9**	

Data Table 4 shows the increase in achievement scores from the beginning of the learning material to the end. The highest achievement in the last material section is a single flower. The highest average achievement per indicator is the indicator of truth-seeking, open-mindedness, and curiosity, which is 95.83. This is in accordance with the Piil Pesenggiri value attached to students. Meanwhile, the lowest indicator achievement average is the systematic indicator, which is 37.5.

The following also shows the relationship data between the results of the ability test juxtaposed with the score on the disposition of the mathematical representation of the questionnaire.

Tabel 5. Hasil Tes Kemampuan dan Disposisi Representasi Matematis

Siswa	NilaiTes	Skor Disposisi	Keterlaksanaan	Keterangan
R1	100	96	80%	**Tinggi**
R2	100	108	90%	**Tnggi**
R3	100	97	81%	**Tinggi**
R4	100	99	83%	**Tinggi**
R5	100	101	84%	**Tinggi**
R6	80	94	78%	**Tinggi**
R7	80	106	88%	**Tinggi**
R8	**75**	**98**	**82%**	**Tinggi**

From Table 5 it can be concluded that students with different abilities are able to achieve satisfactory mathematical representation ability test scores. The implementation of high mathematical representation disposition is balanced with high representation ability. So that it can be said of the 8 subjects that have an interaction between the ability and disposition of mathematical representation.

CONCLUSION

1. The products of social arithmetic didactic design through generative learning models produced in this research and development are as follows;
   a. The didactic design made is a didactic design on social arithmetic material consisting of finding the concepts of gross, net and tare; advantages and disadvantages; discounts and taxes; single interest and complete the assignment sheet.
   b. The learning process follows the steps in the generative learning model, namely exploration, focusing, challenges and application. Learning refers to the development of students' mathematical

representation abilities and dispositions.

c. The assignment sheet given in the social arithmetic didactic design contains indicators of mathematical representation.

d. The implementation of the social arithmetic didactic design through the generative learning model is basically in accordance with the predictions of student responses, while responses that are not in accordance with the predictions are anticipated with didactic and pedagogical actions during the learning process. Therefore, the given didactic situation can be well received by students.

The results of observations of the disposition of mathematical representations show an increase in the achievement value from the beginning of the learning material to the end. The highest achievement on the indicators of truth-seeking, open-mindedness, and curiosity and the lowest achievement of indicators are systematic indicators. Further data shows that the results of the high mathematical representation ability test are balanced with the results of the students' high mathematical representation disposition questionnaire scores

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