

# Didactical Design Material Units of Distance and Speed to Developed Mathematical Connection in Elementary School

R R Jannah\*, S Apriliya, and Karlimah

Departement of Elementary Teacher Education, UPI Tasikmalaya Campus, Jl.Dadaha no. 18, Tasikmalaya, Indonesia.

\*ridharaudotuljannah@yahoo.co.id

**Abstract.** This study aims to develop alternative instructional design based of barriers learning which identified by developing mathematical connection capabilities to the material unit of distance and speed. The research was conducted in the fifth grade elementary school Instructional design is complemented with a hypothetical learning trajectory in the form of a pedagogical didactic anticipation. The method used is descriptive method with qualitative approach. Techniques data collection used were observation, interviews, and documentation. The instrument used the researchers themselves are equipped with an instrument written test. The data were analyzed qualitatively to determine the student learning obstacles, then arrange hypothetical learning trajectory and pedagogical didactic anticipation. Learning obstacle are identified, it is learning obstacle related the connections between mathematical topics, learning obstacle related with other disciplines, and learning obstacle related with everyday life. The results of this research are improvement and development of didactic design in mathematics which has activities mathematical connection to the material unit of distance and speed in elementary school. The learning activities are carried out is using varied methods include method lectures, demonstrations, practice and exercise, as well as using the modified instructional media.

## 1. Introduction

NCTM (2000) states that there are five standard processes that must be owned by the students through the learning of mathematics, namely knowledge of problem solving, knowledge reasoning and proof, communication of mathematical knowledge, knowledge in math connections, and knowledge of mathematical representations. Based on that standar process, the capability of mathematical connection of is one of the basic math skills need to be developed. The material in mathematics have a strong bond, so that the topic connected with another topic. So that students are more successful in learning mathematics, the students should be more given the chance to see the connection-link it, because the primary target of the mathematical connection emphasis in the classroom is that students are not teachers (Fauzi, 2011, p.2). In addition, making connections between the mathematic they learn at school and it's application in they everyday lives not only helps students understand mathematics but also allows them to see how useful and relevant it is in the world beyond the



classroom (Ontario, 2005, p. 16). Math materials that have relevance to other mathematical topics it is material units of distance, time and speed.

In mathematics, knowing the material units of distance and speed is one important matter that must be mastered by elementary school students. In fact, the concept of distance and speed is not a simple concept to be taught and understood by students. Reality on the ground, generally show that the teaching methods used by teachers and students more active passive (Sulistiawati, 20016, p.135). The learning activities that are less actively involve students allow less optimal achievement of learning goals.

Based on preliminary studies that have been done, there are some barriers to learning experienced by students related mathematical connection at the material unit of distance and speed. One of the barriers to learning are as follows.

1 Jarak rumah Adi dan rumah Dede adalah sepanjang gulungan pita 40 m, sedangkan jarak rumah Dede ke sekolah sepanjang gulungan pita 1500 cm.  
Berapa meter jarak rumah Adi ke sekolah jika melewati rumah Dede?  
Diketahui: Jarak rumah adi dan rumah dede = 40 m gulungan pita  
Jarak rumah dede ke sekolah = 1500 cm gulungan pita  
Ditanyakan: Berapa meter jarak rumah adi ke sekolah jika melewati rumah dede?  
Jawab:  $\frac{1500}{40} = 37$

**Figure 1.** Learning Obstacle Material Units of Distance.

5 Andri mengendarai mobil dengan kecepatan tetap 30 km/jam. Jika jarak yang ditempuh Andri sejauh 90 km, berapa jam waktu yang diperlukan Andri untuk sampai ke tempat tersebut?  
dik: Andri mengendarai mobil dgn kecepatan tetap 30 km/jam  
jika jarak yg ditempuh Andri sejauh 90 km  
dit: berapa jam waktu yg diperlukan Andri  
untuk sampe ke tempat tersebut?  
jawab: 30 km/jam

**Figure 2.** Learning Obstacle Material Units of Speed.

Learning obstacle in figure 1 and figure 2 related to understanding the material associated with a unit of distance unit of length and speed unit of material associated with the unit of time. This means that they still do not understand the concept of distance and speed correctly. Lack of understanding of the concept of distance and speed to be one of the major cause of the inability of students to answer the questions correctly. When students are faced with an unusual problem exemplified by his teacher, the students will find it difficult to use their knowledge. This is commonly called the barriers to learning. Brousseau (1997) revealed "there are three factors causing barriers to learning, ie barriers ontogeny (the mental readiness to learn), didactic (as a result of teaching teachers) and epistemology (knowledge of students who have a context of limited application) (Suratno, 2009, p. 2). To overcome the difficulties of student learning about the concept of distance and speed, it is necessary to design a didactic prepared to cope with, and engage students in understanding the formation as a whole, not just limited to one context only. Basically, the teacher should be able to design such that the course of the learning process towards optimum achievement of learning objectives. Teachers not only convey the material being taught and completed the learning targets, but teachers also need to be able to predict student learning obstacles that will arise and have to prepare a didactic Anticipation Pedagogical (ADP) to address the barriers to student learning.

## 2. Research Methods

The method used in this research is qualitative research in the form of a didactic design (Didactical Design Research). Research design didactic basically consists of three stages: analysis of the situation didactic before learning that his form in the form of a didactic design hypothetical including ADP (Anticipation Pedagogical Didactic). analysis metapedadidaktik, and analysis retrospektif linking the analysis results of analysis of the situation didactic hypothetical metapedadidaktik analysis results. Of the three stages will be obtained empirical design didactic that it was likely to continue to be refined through three phases of the DDR. (Suryadi, 2010).

This study is divided into three stages, namely the analysis of the situation before the learning phase, metapedadidaktik analysis and retrospective analysis. Phase analysis of the situation before the learning consisted of collecting literature relating to the material under study, analyzing the material, making the instrument to determine the barriers to student learning, conducting preliminary studies, analyzing the results of a preliminary study, identify barriers to learning, preparing and developing design didactic based of learning obstacle, as well as make response prediction. Metapedadidaktik analysis phase consists of implementing a didactic design, analyze the results of the implementation of the design. Retrospective phase consisted of linking the response predictions that have been made with the response that occurs, preparing and developing didactic design revisions.

The data collection technique used is the test instrument of preliminary studies to identify barriers to student learning, interviews, observation, and documentation. In observation, the researcher served as teachers to observe how the relationship between teachers and students, and the learning process in the material of unit distance and speed.

### 3. Result and Discussion

Based on the analysis of preliminary studies, was found several barriers to student learning. The results of the analysis show the fallacy of students in answering questions related to mathematical connection to the material unit of distance and speed. obstacle of Learning are identified consist of three types, it is learning obstacle related to the connections between mathematical topics, learning obstacle related with other disciplines, and learning obstacle related with everyday life.

#### 3.1. Learning Obstacle Type 1

On learning obstacle type 1 students do not understand the concept of distance unit associated with a unit of length. Similarly, in the material unit of speed, students have not been able to associate the material unit of speed with a unit time. For examples of learning obstacle in the material unit of distance and speed related to the connection between mathematical topics..

1 Jarak rumah Adi dan rumah Dede adalah sepanjang gulungan pita 40 m, sedangkan jarak rumah Dede ke sekolah sepanjang gulungan pita 1500 cm. Berapa meter jarak rumah Adi ke sekolah jika melewati rumah Dede?

Diketahui: Jarak rumah Adi dan rumah Dede = 40 m gulungan pita  
Jarak rumah Dede ke sekolah = 1500 cm gulungan pita

Ditanyakan: Berapa meter jarak rumah Adi ke sekolah jika melewati rumah Dede?

Jawab:  $\frac{1500}{40} = 1500 : 40 = 37$

**Figure 3.** Learning Obstacle Type 1 (Test Item Number 1)

5 Andri mengendarai mobil dengan kecepatan tetap 30 km/jam. Jika jarak yang ditempuh Andri sejauh 90 km, berapa jam waktu yang diperlukan Andri untuk sampai ke tempat tersebut?

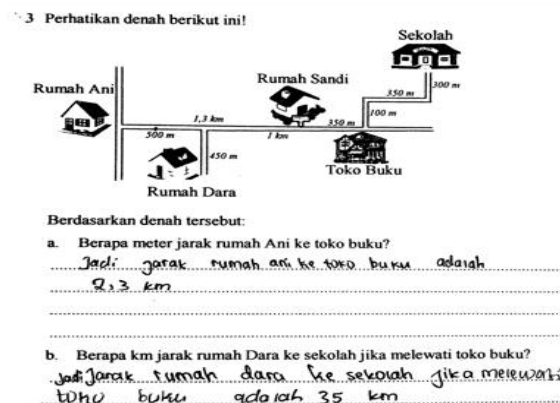
Dik: Andri mengendarai mobil dgn kecepatan tetap 30 km/jam  
jika jarak yg ditempuh Andri sejauh 90 km  
Dit: berapa jam waktu yg diperlukan Andri  
untuk sampe ke tempat tersebut?

Jawab: 30 km/jam

**Figure 4.** Learning Obstacle Type 1 (Test Item Number 5)

#### 3.2. Learning Obstacle Type 2

On learning obstacle type 2 students do not understand the material unit of distance that is associated with other disciplines, namely IPS about the floor plan / map. Students have difficulty when it must resolve the matter. This can be seen in the image problems below.



**Figure 5.** Learning Obstacle Type 2 (Test Item Number 3)

Based on these responses, the students are not familiar with the form of questions contained in the image so that students have difficulties and mistakenly answer the question. Most students answered questions just results without any way to resolve it. There are also students who answered without first equalizing unit distance of each home, so the answer is not quite right.

### 3.3. Learning Obstacle Type 3

On learning obstacle type 3 students do not understand the interrelationships between material units of distance and speed in daily life. Students still confusion as to resolve the problems. This is evident from the responses of students who have difficulty in determining the distance of two places and determine the speed of the car on a journey.

2 Bayu pergi ke toko buku melewati rumah Doni. Jika jarak rumah Bayu ke toko buku 2 km, dan jarak rumah Bayu ke rumah Doni 500 m, maka berapa km jarak rumah Doni ke toko buku?

Dik: Bayu pergi ke toko buku melewati rumah Doni. Jika jarak rumah Bayu ke toko buku 2 km, dan jarak rumah Bayu ke rumah Doni 500 m.  
 Dit: berapa km jarak rumah Doni ke toko buku?  
 Jwb: 2 km + 500 m = 2500 m

**Figure 6.** Learning Obstacle Type 3 (Test Item Number 2)

6 Dani akan melakukan perjalanan dari Tasik ke Jakarta dengan mengendarai mobil. Jarak antara Tasik dan Jakarta sekitar 280 km. Untuk sampai ke Jakarta, Dani memerlukan waktu 7 jam. Berapa km/jam kecepatan yang diperlukan mobil Dani agar tepat waktu sampai di Jakarta?  
 Dik: Dani akan melakukan perjalanan dari Tasik ke Jakarta dengan mengendarai mobil.  
 Dit: Berapa km/jam kecepatan yg diperlukan mobil Dani agar tepat waktu sampai di Jakarta  
 Jwb: 20 km/jam

**Figure 7.** Learning Obstacle Type 3 (Test Item Number 6)

To overcome some of the learning obstacle above, then designed a didactic design to minimize learning obstacle in the material unit of distance and speed. Design which designed this is the development of learning activities commonly conducted teacher in the classroom with the students by developing mathematical connection capabilities. Learning activities with connections in mathematics, can facilitate the students understand math in that material.

When referring to the curriculum in 2006, the material units of distance and speed are in the 5th grade in 1st semester with competence standards is to use angle measurement, distance, time, and speed in solving problems. While basically competence was to know unit of distance and speed. Competence standards and basically competence was developed into indicators and learning objectives. Once indicators and structured learning objectives, then designed a learning activity

relating to the material unit of distance and speed. Before designing learning activities, it must first construct hypotheses learn or Hypothetical Learning Trajectory (HLT) including a student's response prediction and anticipation of learning activities that will be implemented. This prediction response may arise during the implementation of design didactic, and how the anticipation. To facilitate the learning activities, students are given a student activity sheet as a guide to implement learning steps.

The steps of learning activities undertaken in the implementation of this design can be explained as follows.

### *3.3.1. Finding the concept of distance unit associated with a unit length.*

To find the concept of distance unit associated with a unit length, the lesson activities include demonstrations and practice activities. Activities carried out is to measure the length of the classroom using a measuring instrument and meter tape. In the demonstration activities, students must first learn the material of length. Then in practical activities, students learn the material unit of distance. With the connection between mathematical topics, students are guided to find the concept of distance. Once the students understand the concept of distance, students study the various units of distance and how to equalize the distance unit.

### *3.3.2. Calculating the unit of distance associated with the floor plan or maps in learning of social studies.*

In accordance with the theory of Bruner, after a phase of learning activities in a concrete next step is learning activities related to the image (iconic). In this activity the material unit of distance associated with other subjects are social studies about the floor plan / map. Students measure the distance somewhere found on the maps using ribbon and a ruler. This activity begins by measuring the distance somewhere to use ribbon, then the ribbon is measured using a ruler. Through learning activities using images students are expected to better understand the material unit of distance.

### *3.3.3. Calculating the distance unit associated with everyday life in the context of story problems.*

After learning activities in a concrete and through drawings, then the next stage students are trained to be able to solve problems related to everyday life in the form of story problems. In this activity, the first students are guided to understand the context contained in the problem by giving a clue what is known and questioned. Through these activities, students are expected can apply mathematics to solve problems related to everyday life.

### *3.3.4. Calculating the unit of speed related to units of distance and time unit.*

In this activity, speed unit of material studied by conducting practice run. These activities are carried out to determine the speed of the students in running that are associated with the unit of distance and time. Learning activities begins with measuring the distance on the field that will be used to run, and set up a stopwatch to count time. Having in mind the distance and time, students are guided to find the concept of speed by linking these topics.

### *3.3.5. Calculating the unit of speed associated with everyday life.*

To enhance students' understanding of the concept of speed, the students are given exercises form of story problems associated with everyday life. In this activity, students are guided to understand the context of story problems. In order to facilitate the students to understand the problem, researchers used a formula magic triangle "Jokowi" in resolving the matter.

Such activities are implemented in the learning of mathematics in the fifth grade. As for the implementation of activities carried out in the SDN Sangkali. At the time of execution of the didactic design implementation, a variety of student responses that arise can already be anticipated well. Students begin to understand the concept of units of distance and speed unit. But there are still many students who do not really understand the concept of units of distance and speed, especially in determining equivalence formula unit of distance and speed, so that mistakes and errors are still found

in the students 'work on the problems after analyzing the results of the students' work. These events beyond prediction that a student's response prediction and anticipation of didactic and pedagogical that have been made previously need to be modified and developed in accordance with the situations that occur during implementation progress. Therefore, we need a revision of the design to improve the design of didactic earlier. Here's an example of a student's response at the time of the initial didactic design implementation.

**Kegiatan 1 :**

Mengukur panjang ruangan kelas menggunakan pita untuk menentukan jarak dari titik A ke titik B.

1. Berapakah panjang pita yang digunakan untuk mengukur panjang ruangan kelas?  $7.1 m$
2. Berapakah panjang ruangan kelas?  $7.1 m$   $10 cm$
3. Berapakah jarak yang ditempuh dari titik A ke titik B?  $7.1 m$   $10 cm$
4. Jika satuan meter yang digunakan untuk mengukur panjang ruangan kelas diubah menjadi satuan cm, berapa cm panjang ruangan kelas?  $710 cm$
5. Berapa lama waktu yang diperlukan untuk mengukur panjang ruangan kelas?  $02.17$
6. Jika satuan menit yang digunakan untuk menghitung waktu diubah menjadi satuan detik, berapa detik waktu yang diperlukan untuk mengukur panjang ruangan kelas?  $13$

**Figure 8.** Students Response to the Teaching and Learning Material Unit of Distance (Activity 1)

**Kegiatan 2 :**

Mengamati denah lokasi dan mengukur jarak yang terdapat dalam denah.  
Perhatikan denah lokasi di bawah ini!



1. Berapakah jarak rumah Rosa ke SDN Sukumulya?  $48 cm$
2. Berapakah jarak rumah Febri ke rumah sakit Dewi Sartika?  $80 cm$
3. Berapakah jarak rumah Indra ke masjid agung?  $57 cm$

**Figure 9.** Students Response to the Teaching and Learning Material Unit of Distance (Activity 2)

**Kegiatan 4 :**

Menghitung kecepatan siswa berlari di lapangan.

1. Berapakah panjang lapangan di sekolahmu?  $12 meter$
2. Berapakah waktu yang diperlukan untuk berlari dari titik A ke titik B (panjang lapangan), jika pelari berlari dengan kecepatan lambat, sedang, dan cepat?
  - a. Pelari pertama :  $12 detik$
  - b. Pelari kedua :  $3 detik$
  - c. Pelari ketiga :  $2 detik$
3. Berapakah kecepatan setiap pelari jika jarak yang ditempuh sama dan waktu yang diperlukan berbeda?
  - a. Pelari pertama :  $kecepatan = jarak per waktu$   
 $1 meter per detik$
  - b. Pelari kedua :  $4 meter per detik$

**Figure 10.** Student Response to the Teaching and Learning Material Unit Speed (Activity 4)

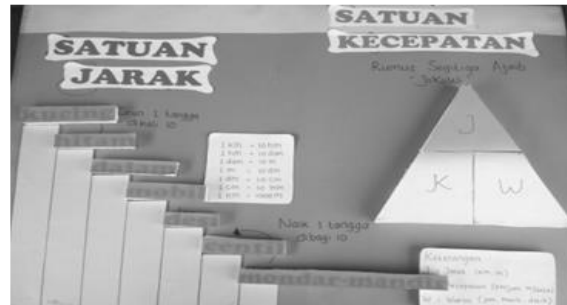
From the analysis work in above, the students still got it wrong in writing unit of distance and speed. Students also have difficulty in determining the equality unit of distance. At the beginning of the didactic design implementation, learning activities that includes demonstrations and practice there are the students still have difficulty understanding the material, so that the necessary improvement and development of didactic design to overcome these obstacles. Didactic design that is fixed in the beginning of the initial design called didactic design revisions.

In the didactic design revisions, learning activities are still the same as the initial didactic design, but there are additional media to help students understand the material and revision sheet of student activity. Instructional media used are media media of unit length and media formula triangle "Jokowi".

This media is designed to make easily students to determine equality unit of distance and determine the formula for speed.

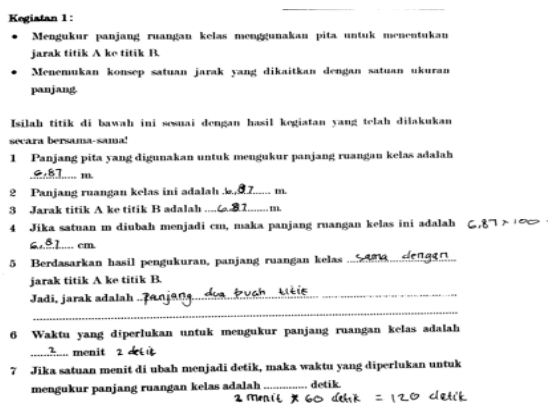


**Figure 11.** Instructional Media Unit of Length and The Magic Triangle Formula “JoKoWi”

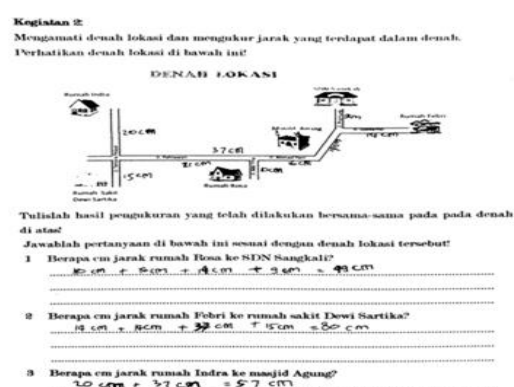


**Figure 12.** Instructional Media Unit of Length and The Magic Triangle Formula “JoKoWi”

The results of the implementation of design revision are most of the students already understand the material unit of distance and speed. Students have started to understand the concepts, procedures define equality unit of distance and determine the formula for velocity through the media that are used during the implementation of the revised design. With the revision of sentence contained in the student activity sheets, can facilitate the students participating in learning activities. In this didactic design, students have increased in response to learning activities. The following for examples of student responses on the implementation of the revision design.



**Figure 13.** Student Responses to the Material Unit of Distance (Activity 1)



**Figure 14.** Student Responses to the Material Unit of Distance (Activity 2)

**Kegiatan 4 :**

- Menemukan konsep satuan kecepatan yang dikaitkan dengan satuan jarak dan satuan waktu.
- Menghitung kecepatan siswa berlari di lapangan.

Isilah titik-titik di bawah ini sesuai dengan hasil kegiatan yang telah dilakukan secara bersama-sama.

1. Panjang lapangan sekolah adalah 15 m.
2. Jarak titik A ke titik B adalah 15 m.
3. Waktu yang diperlukan pelari untuk berlari dari titik A ke titik B, yaitu:
  - a. Pelari pertama : 15 detik.
  - b. Pelari kedua : 8 detik.
  - c. Pelari ketiga : 5 detik.
4. Berdasarkan hasil kegiatan ini, setiap pelari memerlukan waktu yang berbeda untuk menempuh jarak yang sama. eti per lufar  
 Jadi, kecepatan adalah waktu yang ditempuh untuk menempuh jarak tertentu
5. Kecepatan yang digunakan pelari untuk berlari dari titik A ke titik B, yaitu:
  - a. Pelari pertama : Kecepatan = Jarak / Waktu = 15 m / 15 detik = 1 m / detik
  - b. Pelari kedua : Kecepatan = Jarak / Waktu = 15 m / 8 detik
  - c. Pelari ketiga : Kecepatan = Jarak / Waktu = 15 m / 5 detik

**Figure 15.** Student Responses to the Material Unit of Speed (Activity 4)

At the time of implementation of the revision design, students are able to see the connection contained in mathematics, such as connections between mathematical topics, connections with other subjects, and connections with everyday life. Through this didactic design is expected to be obtained by an alternative design of materials units of distance and speed more innovative so that it can help the learning process of students with a more optimal and learning objectives expected to be achieved.

#### 4. Conclusions

Didactic design which produced and developed in this research is an alternative didactic design in mathematics learning at the material unit of distance and speed. This didactic design was developed based on learning obstacle which identified by developing students' mathematical connection capabilities. Learning obstacle which identified in this research, namely learning obstacle related to the connections between math topics, connections between mathematics with other disciplines, and the connection between mathematics to everyday life. This didactic design can create a more active learning situations so that it can minimize barriers to learning and make students more easily understand the subject matter. Through this didactic design, students can find connection contained in mathematics so as to improve students' mathematical connections.

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