Local Instruction Theory (LIT) on spherical geometry for enhancement students’ strategic competence

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Abstract. This research focused on the analysis of the materials spherical geometry of the wake in an attempt to enhance the strategic competence of students and to produce learning trajectory. That is because the materials that are used less catchy concept gives students. Learning materials with Local Instructional Theory (LIT) can enhance the strategic competence of the students. This research aims to study the difference of achievement and improving the strategic competence of the students who got the Realistics Mathematics Education (RME) and (LIT) with conventional learning. This research is the Design Research with two cycles. This research has three phases i.e. 1) preparing for the experiment/preliminary; 2) teaching experiment; 3) retrospective analysis. The population of the research was the whole IX group junior high school 1 Rajapolah with samples of IXg and IXj group. Results of the analysis of the data shows that students based on Mathematical Prior Knowledge (MPK) acquire learning achievement have RME and LIT and enhancement strategic competence of the mathematical that are higher than those of students who obtain the conventional learning.

1. Introduction

The need for understanding and applications of mathematics in everyday life or the world of work has become something great and will continually increase, so that the situation can be illustrated as follows: (1) mathematics for life. Mathematical knowledge becomes satisfaction and personal abilities. The Foundation of everyday life will be the increasing technology and mathematics, (2) mathematics as part of culture heritage. Mathematics is a cultural and intellectual ability of humans, (3) mathematics for the workplace [1]. As well as the stages of mathematical necessity in creating a smart society, mathematical thinking ability and problem solving are also required in the job, an increase of professionalism which lies in the area of health up to graphic design, and (4) mathematics for the scientific and technical community. All fields require knowledge of the basics of mathematics, even high level mathematics [1].

The four goals of education math that: (1) For the practical needs in everyday life or at work, (2) as a prerequisite for further study, (3) value of culture (as a result of human culture, the beauty of Mathematics (work of art) to appreciate the role of mathematics in the community), (4) Thinking in mathematics (logic) [2]. There are five mathematics competences to be developed in teaching mathematics at school [3]. They are: (1) strategic competence. The knowledge of concepts, operation and mathematics relation, (2) procedural fluency. The ability to apply the procedure accurately, efficiently, and appropriately, (3) strategic competence. The ability to formulate, present, and solve the problem, (4) adaptive reasoning. The ability of logical and reflective thinking and the ability of
explainin
g, and (5) productive disposition. The tendency to perceive mathematics as beneficial and
valuable thing as well as the conviction of self-esteem. Three out of five competences, which are
basic, are strategic conceptual understanding, strategic competence and productive disposition. In
addition, there are sets forth that the General purpose of learning mathematics is so that students can
have the ability of such understanding, reasoning, problem solving, communication, and attitude to
appreciate the usefulness of mathematics in everyday life Curriculum Content Standards outlined in
that mathematics is the science that underlies the universal development of modern technology, have a
very important role in a variety of disciplines and advancing the human intellect [4].

The students must be able to comprehend the concepts and well behave [3,4]. Mathematics learning
at school must be able to develop students’ mathematics skill because it is one of the objectives that
achieved in modern era [5]. There are five mathematics competences to be developed in teaching
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and appropriately, (3) strategic competence. The ability to formulate, present, and solve the problem,
(4) adaptive reasoning. The ability of logical and reflective thinking and the ability of explaining, and
(5) productive disposition. The tendency to perceive mathematics as beneficial and valuable thing as
well as the conviction of self-esteem [6].

Strategic competence is the competence to extremely support the memory because learning fact
and method through understanding has been continuously conducted to make the students easily
memorize, utilize, and reconstruct it when the students forget. So, the teacher must create learning
design to achieve the expected competence [7]. Thinking process must be designed in such a way to
make mathematics learning meaningful.

Based on earlier research and students’ error analysis in trajectory material, the teacher must
consider Hypothetical Learning Trajectory (HLT) coming up in mathematics learning. HLT is
formulated in three components. they are; (1) learning objective, (2) learning instruments, and (3)
hypothetical learning process. It anticipates the process of developing students’ critical thinking and
creative mathematics. So, formulating (HLT) and focusing on pedagogy and didactic are essential in
developing learning design.

Based on the foregoing, it is in developing a design draft learning needs to formulate hypothetical
learning trajectory (HLT). Related to earlier explanation, mathematics learning ought to be given by
motivating the students to do the discovery under the teacher’s scaffolding to creating Local
Instructional Theory. The suitable learning approach is Realistic Mathematics Education (RME).
Related to RME, mathematics must be perceived as a human activity not as a learning material that
should be directly transferred as ready-to use mathematics. Mathematics learning aims at providing the
students an unlimited chance to reinvent called guided reinvention [8].

2. Methods
This research uses design research to design trajectory material under realistic approach (Realistic
Mathematics Education). This design is appropriate to answer research questions and attain research
purposes. This research design defines a systematic analysis that designing, developing, and
evaluating the intervention toward education (program, strategy, learning material, product, and
system) as a solution to solve the complicated problems in education [9]. The cyclic occurs in design
research. It is a repetitive activity from thinking experiment to learning experiment in diagram
illustrating the experiment idea [10].

Design research has the objective to develop a theory which is based on LIT that are based on the
empirical basis of the experiment through collaboration between researchers and teachers aim to
increase research relevance by having educational policies and practices [11].

3. Result and Discussion
There are 3 phases in the implementation of the design research [12] that is:
Phase 1: preparing for the experiment /preliminary.
This design functions to implement initial ideas from literature analysis regarding learning of trajectory material, RME approach, curriculum, and research design as the basic formulation of students’ preliminary strategic hypothesis in learning spherical geometry. Next step is the implementation of designing hypothetical learning trajectory (HLT) which is the sequence of trajectory learning activity by utilizing RME approach where HLT contains three aspects [12]. Those aspects are: 1) learning objective; 2) learning activity; and 3) students’ thinking prediction. That prediction is adjustable to students’ reaction during learning process and it is revisable within experiment teaching process because students’ prediction is dynamic. That students’ prediction turns out to be a guidance to anticipate upcoming students’ thinking and strategy. The analysis result of phase two is the design of learning activity to gain the learning objective having made from every learning phase and the prediction of students’ activity shortcut in achieving learning objective.

Phase 2: The design of experiment (teaching experiment)
In his mathematical teaching cycle, states that the teacher ought to try predicting before students’ mental activity occurs (thought experiment), try discovering the process of students’ thinking (teaching experiment) [13]. So, this experiment design is divided into two experiments: 1) pioneering experiment as a bridge between initial design phase and teaching experiment. Pioneering experiment aims at: a) tracing students’ previous knowledge, b) collecting data to support the planning adjustment of previous learning shortcut. 2) teaching experiment aims at collecting data to answer research question. In experiment phase, the researcher conducted learning in experiment group under RME and LIT learning. In control group, RME learning was applied. Students' recapitulation of MPK results based on learning and all including minimum score, maximum score, mean and standard deviation are presented in Table 1.

Table 1. Recapitulation of student mathematical prior knowledge results based on learning

| Learning  | N  | Score  | Mean | Standard Deviation |
|-----------|----|--------|------|--------------------|
| RME LIT   | 62 | 5      | 13   | 7.52               |
| RME       | 62 | 1      | 9    | 5.34               |

Based on Table 1, overall MPK's mean based on RME LIT learning is relatively the same as RME learning. However, diversity can be seen from standard deviation. Before choosing the test used to check the mean difference of MPK data then normality and homogeneity test should be done. The normality test criteria of MPK results, H0 is accepted if the probability value (sig.) is bigger than α = 0.05 and H0 is rejected if the probability value is less than α = 0.05. The statistical test used to test the hypothesis is the Shapiro-Wilk test. Different Test Two Data Rates of Strategic Competence Enhancement Based on Mathematical Prior Knowledge (MPK) in Table 2.

Table 2. Different test two data rates of strategic competence enhancement Based on Mathematical Prior Knowledge (MPK)

| MPK       | Statistic Test | Statistic Value | Significant | Conclusion   |
|-----------|----------------|-----------------|-------------|--------------|
| High      | Test t’        | 6.58            | 0.000       | H0 is rejected |
| Middle    | Test t’        | 7.22            | 0.000       | H0 is rejected |
| Low       | Test t’        | 5.06            | 0.000       | H0 is rejected |

H0 : The average difference of control and experiment group is the same (\(\mu_e = \mu_k\))
H1 : The experimental group is higher than the control group (\(\mu_e > \mu_k\))

In the Mathematics Prior Knowledge (MPK) of high, middle, and low value significance more less α = 0.05, means H0 not assumed. That is, for the MPK of high, middle, and low MPK to enhancement strategic competence experiment group is significantly different from conventional group. In general it
can be concluded also that based on the students early mathematical ability of high, middle and low
category, the enhancement of strategic competence of students who acquired mathematics learning
with student learning who get RME with LIT is better than the students who get the learning
mathematics with the conventional.

Phase 3; retrospective analysis
This phase analyzes the data from teaching experiment and the data result was used to plan the activity
and develop the activity design of the next learning. In general, retrospective analysis aims at
developing LIT. In this phase, the data obtained from the phase of Teaching experiment are analyzed
and the results of its analysis are used to plan activities and develop learning activities on the design of
the next. In general the aim of the analysis is to develop the retrospective LIT. That based on [14] and
[15].

4. Conclusion
The results of the discussion that has been presented, the researchers concluded that the study design
research methods through RME has a very large contribution to generating and LIT in HLT learning
material spherical geometry [16-18]. Through the activities carried out by the students, the virtue of
LIT area and volume of a cone, cylinder, and sphere. LIT produced in this research is the result of
path-the path of learning that is designed on the previous stage. Based on that, the strategic
competence LIT related concepts are wide and spherical geometry volume can be increased. In general
it can be concluded also that based on the students' early mathematical ability of high, medium and
low category, the enhancement of strategic competence of students who acquired mathematics
learning with student learning as tutor is better than the students who get the learning mathematics
with the conventional.

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