Analysing Diagnostic Assessment on the Ratio of Sine in a Right Triangle

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Abstract. This study aims to develop diagnostic assessment with the special topic of the ratio of sinus in a right triangle and analyze the result whether the students are ready to continue to the next lesson of trigonometry specially the sinus rule. The methodology that use in this study is a design research of Plomp model which is it comprises of 3 phases: (a) preliminary research; (b) prototyping phase; and (c) assessment phase. The findings show that almost half of students made a mistake in determining the ratio of sin in a right triangle, consequently the procedure for solving the problem went wrong. In strategic competency and adaptive communication most of students did not solve the problem that was given. According to the result, the students have to get remedial program before to the next lesson, the rule of sin.

1. Introduction
Assessment plays an important role in achieving the objectives of learning mathematics as a tool to obtain important information about the progress of students, both in knowledge, attitude, and skills. Measuring the progress of them certainly cannot be done only at the end of learning course as an evaluation material, but the progress of students will be monitored well with the assessment that is held continuously at the time of learning [1]. Every interaction that occurs between teacher and students, students to students, and students with the environment is a condition that creates them to learn mathematics.

Creating an atmosphere of learning that can develop the potential of students is one of the tasks of teachers in a professional manner. Like Ball said that teachers should anticipate what students might think and what makes them misinterpreted in mathematics learning [2]. Teachers need to predict what makes students become interested and motivated in the learning process of mathematics. One study of Good & Brophy conclude that teachers who interact with students in the classroom can improve self-confidence, classroom management better, get a positive response from the students, and get an effective response from the challenges given, so that indirectly can improve the achievement of students in learning [3].
Conducting diagnostic assessments to students before designing learning is also one way to gather information as [5]: find out what students know and can do; identify student strengths and plan an instruction which builds on and extends those strengths; target difficulties, identify the precise nature of them, and plan instructions to meet those difficulties; and make informed decision about where to focus instructional time and effort. Ketterlin-Geller discussed diagnostic assessment to diagnosis in mathematics and highlighted the strengths and limitations of diagnostic approach, cognitive diagnostic assessment, skill analysis, and error analysis, for making learning decisions. He point to cognitive diagnostic assessments as an emerging solution for providing detailed and precise information about students’ thinking that is needed to provide appropriate educational opportunities for students struggling in mathematics [5]. However, we need to know is the learner achieves mathematical proficiency that has 5 skills that are tied to one other [6]: conceptual understanding; procedural fluency; strategic competence; adaptive reasoning; and productive disposition.

Alternatively, the diagnosis may assume an instructional definition in which assessment results provide information about students' mastery of relevant prior knowledge and skills within the domain as well as preconceptions or misconceptions about the material [5]. Teachers use this information to adjust the instruction by identifying which areas students have and have not mastered. This results in varied instructional plans that are responsive to students' needs [7], [8]. However, the time involved in administering, interpreting, and implementing changes based on these approaches may be instructed by instructional decisions [9].

2. Experimental Method

2.1. Research approach

In this study the researcher uses the steps of design research (design research) model of Plomp with the following steps [10]:

1) Preliminary research
   Preliminary research needs and context analysis, literature review, developing conceptual and theoretical frameworks for research.

2) Prototyping stage
   The design process is cyclical and sequential in the form of a more micro-process research and uses formative evaluation to improve and improve the intervention model.

3) Assessment phase
   Assessment phase is a semi summative evaluation to conclude whether the solution or intervention is in accordance with the desired and proposed the development of the intervention model.

   Design research with the Plomp model can answer research questions on how to design diagnostic assessments with the aim of collecting information related to students' readiness to learn the law of sinus.

2.2. Subject and Place

   The study was implemented in senior high school.

2.3. Data Collecting Technique

   Data collection technique in this study is through literature studies and field studies. Specifically, data collection in this study is by conducting diagnostic assessment (diagnostic assessment), interviews, observation and documentation. Interviews were conducted after carrying out diagnostic assessments. This interview guide is not rigid, but flexible in accordance with the respondent answer. Observations are made directly by the author during the implementation of diagnostic assessments, interviews and implementation of assessment design for learning. Meanwhile, documentation is done to obtain data directly from the place of research, books and other relevant data.
2.4. Data Analysis

Based on the design research steps formulated by Plomp (2007) that is conducted with 3 stages, namely preliminary research, prototyping stage, and assessment phase.

Preliminary research: Activities at this stage is the stage of preparation for design a diagnostic assessment. This stage consists of literature studies to collect the literature needed to design diagnostic assessments, observe the classes to be studied to obtain preliminary data on field conditions, such as observing teaching and learning activities, and assessing what teachers do in the classroom.

Prototyping stage: at this stage is the design phase is cyclical. Meaning that in the process of designing revision is done based on the results of discussions with teachers who teach the experienced and lecturer of mathematics education. In addition to designing a diagnostic assessment at this stage it is also designing assessment tools such as grid, grid size, rubric scoring mathematics, and key answers to diagnostic assessments that have been designed.

Assessment phase: At this stage it will be analysed to what extent the readiness of the students to study the law of sinus, what errors students are doing, and what misconceptions occur in the ratio of sinus in a right triangle as the prerequisite material for the study of the law of sinus.

3. Result and Discussion

The result of development a diagnostic assessment are instruments that is consist of rubric scoring, answer key and written test consisting of 4 items. The grid problem is designed in accordance with the mathematical syllabus that is tailored to the purpose of mathematics learning, which measures the ability of mathematics that must be possessed by students. Conceptual understanding refers to the learner's ability to understand and relate mathematical ideas and understand the way in which they are used to achieve solutions is an indicator that learners master the conceptual understanding of a mathematical subject. Procedural fluency refers to the students' knowledge of procedural knowledge of when and how to use properly, and the ability to work flexibly, accurately, and efficiently. Strategic Competence refers to the ability of learners to define, model, and solve problems of mathematics. Adaptive Reasoning refers to the ability of students to think logically about the relationship between a concept and a mathematical situation.

Item 1 is intended to measure students' understanding of the sin ratio on the right triangle. Based on the results of the diagnostic assessment performed on the first grade of senior high school, almost half the students mistakenly determine the opposite side of the angle, the adjacent side of the angles and hypotenuse side of the right triangle if the image on the triangle is not in the normal position. Here is the question form given. Some forms of student work errors can be seen in Figure 1.

How can you find the length of $\overline{BC}$?

![Figure 1. Conceptual understanding test of ratio sine in a right triangle.](image)
Figure 2. Error in determining the length of side $BC$.

Items 2 and 3 are intended to measure students’ strategic competence and procedural fluency by linking their knowledge of the sin ratio on the right triangle. Based on the results of diagnostic assessment, students who find the idea to solve this item make a mistake on the operation in determining the length of the side $AC$ or the length of the side $BC$. Most students, however, can not correctly determine the known length of the sides, due to errors in determining the opposite side of the angle, the adjacent side of the angle and hypotenuse side of the right triangle. The errors in the solution of item 2 can be seen in figure 2.

Figure 3. Strategic competence and procedural fluency test.
Figure 4. Errors in determine the opposite side, the adjacent side and hypotenuse side of the right triangle.

Item 4 is intended to see how learners can communicate their ideas. But almost all students could not explain, did not even have an idea where to start to solve the given problem. The biggest mistake that many appear was, they still use the comparison sin on the right triangle, though the given problem is an arbitrary triangle. The errors in the completion of item 4 can be seen in figure 6.

Is it true if length of $\overline{AC} = 12 \text{ cm}$, $\angle A = 60^\circ$, and $\angle B = 45^\circ$, than the length of $\overline{BC}$ is $5\sqrt{5} \text{ cm}$? Explain!

Figure 5. Adaptive reasoning item
Figure 6. Misconception determines the length of side $\overline{BC}$ of triangle ABC.

4. Conclusion
From the results of diagnostic assessment conducted, obtained information that the majority of students on the subject of this study still needs teacher guidance to re-understand the comparison of sinus in a right triangle. In designing the next lesson related to the sin comparison on the right triangle it is necessary to note the stages of learning, so that the learning is designed in accordance with the ability of students, as well as the stage of intellectual development.

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