

## **DIAGNOSING STUDENTS' LEARNING DIFFICULTIES IN THE EYES OF INDONESIAN MATHEMATICS TEACHERS**

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### **Abstract**

Teachers' diagnostic practice on students-difficulties is one of the important steps in designing and managing classroom lessons. The purpose of this study was to explore teachers' perception and practices regarding diagnosing students' learning difficulties. The participants of the study were 28 Indonesian mathematics teachers of Junior High School. The data was collected through a Focus Group Discussion and a teacher questionnaire. The data were analyzed qualitatively to describe how the teachers perceive learning difficulties and how the teachers diagnosed students' learning difficulties. The results of the analysis reveal that the teachers do not yet perform an in-depth diagnosis of students' difficulties in learning mathematics. The teachers only focus on the mathematics topics and non-mathematical issues, instead of on students' thinking process. The teachers also do not differentiate the diagnosis, evaluation, and prediction test. With regard to the strategies used by the teachers to diagnose students' difficulties, analyzing students' responses to tests was the majority. In this respect, observing students' learning process during classroom activities is rarely done by the teachers in the purpose of diagnosing students' learning difficulties. The results of the diagnosis are mainly used as the basis for remedial and drill and practices. The results imply that more support is needed for teachers to improve their competences particularly in diagnosing students' thinking process difficulties when learning mathematics.

**Keywords:** diagnosis, learning difficulties, teachers' perception, teachers' practices

### **Abstrak**

Praktik diagnosis terkait kesulitan siswa dalam belajar merupakan salah satu langkah penting ketika mendesain dan mengelola proses pembelajaran di kelas. Tujuan penelitian ini adalah mengeksplorasi persepsi dan praktik yang dilakukan guru terkait mendiagnosa kesulitan belajar siswa. Penelitian ini melibatkan 28 guru matematika Sekolah Menengah Pertama (SMP) dari Indonesia. Data dikumpulkan melalui *Focus Group Discussion* (FGD) dan angket guru. Data dianalisis secara kualitatif untuk mendeskripsikan bagaimana persepsi guru tentang kesulitan belajar dan bagaimana cara yang dilakukan guru dalam mendiagnosa kesulitan belajar siswa. Hasil analisis menunjukkan bahwa guru belum melakukan diagnosa kesulitan siswa dalam belajar matematika secara mendalam. Guru hanya fokus pada aspek matematika itu sendiri tanpa memperhatikan proses berpikir siswa. Selain itu, guru juga kurang mampu membedakan antara tes diagnosa, evaluasi, dan prediksi. Strategi yang paling sering digunakan guru untuk mendiagnosa kesulitan belajar siswa adalah dengan menganalisis hasil tes siswa. Dalam hal ini pengamatan proses belajar siswa selama kegiatan belajar mengajar jarang dilakukan guru untuk mendiagnosa kesulitan belajar siswa. Hasil penelitian ini menunjukkan bahwa kemampuan diagnostik guru masih perlu dukungan terutama untuk mendiagnosis kesulitan proses berpikir matematika siswa.

**Kata kunci:** diagnosa, kesulitan belajar, persepsi guru, praktik mengajar guru

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A number of studies have shown that mathematics is experienced as a difficult subject by many students in various levels of education. In elementary school level, Wijaya (2017), for example, revealed students' difficulties with fractions. Students in his study understood fractions as parts of a whole, but more than 90% of these students were unable to solve problems involving fractions as parts of a collection of objects. Mathematics is also difficult for secondary school students. Retnawati,

Kartowagiran, Arlinwibowo, and Sulistyarningsih (2017) revealed that only 5% of junior high school students in their study who could deal with fractional exponents such as  $4^{2/3}$ . The concept of subset and parallel lines are also difficult for these students as indicated by the low percentages of students' correct answer, i.e. only about 30%. In upper secondary school, Coşkun (2008) revealed that students experience difficulties with: (1) division algorithm that forms the basis of modular arithmetic, (2) symbolic representation of the division algorithm with modular arithmetic notation, and (3) equivalence class with the concept of mod. Difficulties with mathematics are also experienced by university students. A study of Klymchuk, Zverkova, Gruenwald, and Sauerbier (2010) revealed that many university students could not construct a simple function that representing a familiar context. A general perspective on students' difficulties in mathematics is given by Russell, O'Dwyer, and Miranda (2009) who found that students' difficulties in mastering concept occur are caused by students' inability to link between the knowledge that they are studying and the prior knowledge they have.

Awareness of the difficulties experienced by students in their learning process is an important first step for teachers to design and manage mathematics lessons (Çiltas & Tatar, 2011; Wijaya, van den Heuvel-Panhuizen, Doorman, & Robitzsch, 2014; Wijaya, 2016; Saleh, Prahmana, Isa, & Murni, 2018). In this respect, analyzing students' learning difficulties is often seen as a crucial step to access students' reasoning (Brodie, 2014; Muttaqin, Putri, & Somakim, 2017; Mutohir, Lowrie, & Patahuddin, 2018). Analyzing students' difficulties can be a preliminary step in the process of improving student performance because it sheds light on key aspects of students' learning process that need to be developed. After diagnosing students' difficulties in learning mathematics, Tall and Razali (1993) recommend that less able students cannot be simply helped by providing them with specific strategies to overcome their specific errors. These students also need overall powerful mathematics strategies. Furthermore, on the basis of their analysis Tall and Razali also highlight that developing the confidence of less able students is also an important step to help them gain a better result in mathematics. Another example of instructional recommendation on the basis of analyzing students' difficulties can be found in the study of Wijaya, et al. (2014). The results of an error analysis conducted by Wijaya, et al. (2014) imply that improving the task comprehension of students requires a focus not only on students' language competence, but also on the ability to select relevant information. Furthermore, the ability to identify the required procedure or concept was found to be another key competence that needs to be improved.

To identify and overcome students' difficulties during their learning process are not only a requirement of modern education, but also parts of teachers' responsibilities (Çiltas & Tatar, 2011; Nor, Ismail, & Yusof, 2016). This is in agreement with one of the principles for school mathematics proposed by the National Council of Teachers of Mathematics (2000) that an effective mathematics teaching requires teachers to understand what students know and need to learn. Such understanding forms a basis for teachers to support their students to learn mathematics well. Therefore, it is crucial for teachers to be aware of their students' difficulties in learning mathematics in order to develop and perform learning activities effectively (Yetkin, 2003; Aris, Putri, & Susanti, 2017; Nuari, Prahmana, & Fatmawati, 2019).

This expectation implies that teachers need to have a competence to identify students' learning difficulties. With respect to the teaching of foreign language, Edelenbos and Kubanek-German (2004) defined a so called 'teacher's diagnostic competence' as "the ability to interpret students' foreign language growth, to skillfully deal with assessment material and to provide students with appropriate help in response to this diagnosis" (p. 260). Transforming this idea into the teaching of mathematics, teacher's diagnostic competence could be defined as teachers' ability to interpret students' thinking and reasoning process, to monitor students' progress and difficulties, and to provide appropriate responses to the results of the diagnosis. With respect to diagnostic competence, students have different preconditions therefore teachers need to recognize each student (Tolsdorf & Markic, 2017) and must be able to describe and interpret the individual student's abilities and difficulties.

The present study was aimed to investigate diagnostic practices reported by teachers particularly mathematics teachers. This investigation includes not only how teachers perform the diagnosis, but also teacher's perspective on students' learning difficulties.

## **METHOD**

The present study was a qualitative research employing Focus Group Discussion (FGD) and survey through questionnaire. FGD was chosen because of the following reasons it is a powerful exploratory tool that could provide information about how people think, feel, and act regarding a particular topic (Freitas, Oliveira, Jenkins, & Popjoy, 1998). A total of 28 Indonesian mathematics teachers of Junior High School participated in the FGD. The participants were selected using convenience sampling. The FGD was aimed to uncover diagnostic practices that have been done by teachers in relation to students' learning difficulties. It was conducted in about 4 hours and recorded yet remain anonymously.

In addition to the FGDs, the teacher's participants also filled in an open questionnaire. The FGD and the questionnaire covered the following issues:

1. teachers' perception on students' learning difficulties,
  - Do you notice if your students have difficulties in learning mathematics?
  - How do you know about diagnosing students' learning difficulties? Have you read particular books about diagnosing students' learning difficulties?
2. teachers' practices with regard to diagnosing students' learning difficulties,
  - How do you diagnose your students' learning difficulties?
  - When do you usually diagnose students' learning difficulties?
  - Do you encounter any difficulty in developing proper instrument to diagnose students' learning difficulties?
  - When using multiple-choices items, do you use proper distractor as a tool to diagnose students' learning difficulties?

3. teachers' actions as the responses to the results of diagnosis,
  - In general, what kind of learning difficulties do your students have?
  - What kind of difficulties do your students have when particularly learning mathematics?
  - How do you classify students' learning difficulties?
  - How do you respond or follow up the results of diagnosis? What kind of actions do you usually take?
  - How do you report students' learning difficulties? To whom do you give the report?
  - In your opinion, what parties who should be responsible to take an action in response to students' learning difficulties?
4. the parties who are involved or informed regarding students' learning difficulties
  - Are the other parties that also take an action in response to students' learning difficulties? If so, who are they?
5. needs or tools to diagnose students' learning difficulties
  - Do you use particular software(s) as a tool to diagnose students' learning difficulties? If so, what are the advantages and disadvantages of using the software(s)?
  - In your opinion, do you need a software that is particularly designed to diagnose students' difficulties in learning mathematics? If so, what kinds of specification?

In the first step of analysis, the questionnaire data was reported quantitatively to show the occurrence of particular practices (in percentage) with regard to diagnosing students' learning difficulties. In the next process, this data were described qualitatively and supported by the results from the FGDs.

## **RESULT AND DISCUSSION**

The results of this study are organized into four categories, i.e. (1) teachers' perception on students' learning difficulties, (2) teachers' practices with regard to diagnosing students' learning difficulties, (3) teachers' actions as the responses to the results of diagnosis, and (4) the parties who are involved regarding students' learning difficulties.

### ***Teachers' Perception on Students' Learning Difficulties***

The teachers were asked to mention the difficulties experienced by their students in learning mathematics. The teachers reported various difficulties, around 61% of the difficulties indicated by the teachers were related to mathematics. These difficulties include a lack of calculation skills, low understanding of algebra, and also inability to make a mathematical model representing a contextual problem. Some other Indonesian teachers only listed mathematics domains or topics, such as algebra, geometry, and function without detailed indication about the students'. These Indonesian teachers seemed to focus on the mathematics itself, not on their students' thinking process. The remaining 39%

of the difficulties referred to non-mathematical difficulties. These difficulties include a lack of motivation, careless, and ignorance. Interestingly, such non-mathematical difficulties are still mentioned when the Indonesian teachers were asked specifically about their students' difficulties in learning mathematics, i.e. about 23% of teachers' responses.

### ***Teachers' Practices with Regard to Diagnosing Students' Learning Difficulties***

With regard to teachers' practice in diagnosing students' learning difficulties, there are two main concerns, i.e. the period when teachers diagnose students' difficulties and the instruments which are used by teachers. The questionnaire shows that 53% of the Indonesian teachers diagnosed their students' learning difficulties during the mathematics lessons. About 42% of the Indonesian teachers reported that they performed the diagnosis after the completion of teaching a particular topic. The remaining 5% of the Indonesian teachers said that they diagnosed students' difficulties at the beginning of the semester. Based on these results, it seems that the Indonesian teachers did not distinguish diagnosis (or formative assessment), evaluate (or summative assessment), and prediction test. The fact that the teachers 'diagnose' students' difficulties after the completion of a particular topic indicates that the teachers perform an evaluation, instead of a diagnosis. During the FGD many teachers reported that they perform the diagnosis after a series of lesson addressing a particular topic in order to see whether their students accomplished the learning objectives. Few teachers reported that their schools administer a kind of bridging test or a so called of matriculation test at the beginning of semester in order to get information about students' prior knowledge. Such practice also does not fit the purpose of diagnosis. Despite these inappropriate practices of diagnosis, more than a half of the teachers showed a good understanding of diagnosis process. These teachers reported that they investigate students' difficulties during the teaching and learning process.

The second concern regarding teachers' practice in diagnosing students' difficulties is the instrument or ways to diagnose. The questionnaire data show that most Indonesian teachers used more than one ways or instruments. The most frequently used ways to diagnose students' learning difficulties was test, i.e. 56%. The Indonesian teachers reported that they diagnosed students' learning difficulties by administering a test and analyzing its results. The Indonesian teachers also reported that they also diagnose students' difficulties through observation during the learning process, i.e. 28%. The teachers explained that they could identify students who experienced difficulties by observing students' gesture and the kinds of questions posed by students. The last way that used by the Indonesian teachers to identify students' difficulties was interview or conversation, i.e. 17%. The teachers explained that they could diagnose students' difficulties through conversation. However, the FGD data indicates that some teachers did not entirely diagnose students' difficulties during the conversation because what they asked mainly about whether or not their students like mathematics and what make students like or dislike mathematics.

### ***Teachers' Actions as the Responses to the Results of Diagnosis***

The third issue that was explored in the present study is investigating what the teachers do after diagnosing students' learning difficulties. The finding about this issue could provide information whether the teachers diagnose students' difficulties as a part of their attempt to conduct an effective teaching or not. Based on the data from questionnaire and FGD, there are four types of action that were performed by the Indonesian teachers after diagnosing students' learning difficulties. The most frequently performed action was remedial, i.e. 48%. The teachers reported that they conducted a remedial when many students in their class had difficulties in learning mathematics. This remedial was mainly in the form of re-teaching the difficult topic. For the remedial, the teachers still used their regular teaching strategies. The teachers also often gave drill and practices, i.e. 31%, to overcome students' learning difficulties. They gave students similar tasks to solve. Only 17% of teachers' actions were in the category of developing or planning new teaching strategies. Some teachers explained that students' learning difficulties might be influenced by the teachers' teaching strategies. Therefore, these teachers tried to find new teaching strategies to overcome students' learning difficulties. In this respect, these teachers explicitly mentioned joyful learning. It indicates that the teachers consider students' uncomfortableness during the learning process is a cause for students' learning difficulties. The least frequently performed action was developing teaching media, i.e. 5%. Some teachers argued that a lack of media might contribute to students' learning difficulties; therefore, designing appropriate media is an important action to take after diagnosing students' difficulties.

### ***The Parties Who are Responsible to Overcome Students' Learning Difficulties***

The teachers were asked about the parties who should take action regarding the results of the diagnosis. In general, the Indonesian teachers mentioned four parties, i.e. the school principal, teachers, school counselor, and parents. According to the teacher, school principal need to take action at school level to overcome and prevent students' learning difficulties. It might be in the form of school program such as extra study hours at school. The teachers themselves are the main actor who should take action on the basis of their students' learning difficulties. In an addition to principal and teacher, school counselor is also an important party who should participate in overcoming students' learning difficulties. The involvement of school counselor seems to correlate to teachers' perception that students' difficulties in learning mathematics include non-mathematical aspects, such as students' motivation and careless. Lastly, the Indonesian teachers emphasize that overcoming students' learning difficulties is not only the responsibility of teachers and schools, but also the parents' responsibility.

The present study was aimed to explore teachers' perception on students' learning difficulties and teachers' practice in diagnosing students' learning difficulties. With regard to the teachers' perception, the results of the study show that the teachers do not perform in-depth diagnosis of students' difficulties in learning mathematics. The teachers do not thoroughly identify students' thinking process in relation to the mathematics concepts they are learning. Paying more attention to such specific aspect

could help teachers perform an appropriate follow-up action other than re-teaching. As recommended by Ciltas and Tatar (2011), teachers could identify appropriate teaching methods when they have enough information about students' thinking process. Similarly, NCTM (2000) also emphasize a need for understanding what students know and need to learn in order to provide support for students. Another important finding of the present study is the fact that the teachers also do not differentiate diagnosis, evaluation, and prediction test. Regarding the strategies used by the teachers to diagnose students, analyzing students' responses to tests was the majority followed by observation and interview.

## CONCLUSION

The teachers perform various actions on the basis of their finding in diagnosing students' difficulties in learning mathematics. The major action taken by the teachers is remedial in the form of re-teaching. Many teachers also perform drill and practices to overcome students' learning difficulties. Developing teaching strategies and media that fit students' learning difficulties is a minor action taken by the teachers.

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