The Mathematics Educator
1999, Vol. 4, No.1, 97-103

DIAGNOSING STUDENTS WITH LEARNING DIFFICULTIES IN MATHEMATICS

Jessie Ee

Abstract

Accuracy is essential in the diagnosis of mathematical difficulties faced by students if we are to intervene and provide appropriate remediation. Yet often times, diagnosis of students' mathematical difficulties are assessed merely through their written work or monthly assessments only. This article discusses the inadequacies of merely assessing students' written exercises and highlights the necessity to include a personal interview on the mathematical concept with the student concerned. Some essential interview strategies such as illustrations, redirection, generalization and questions are included to assist teachers gain insights into their students' mathematical understanding. Suggestions in administering an interview for various mathematical concepts are also included.

Short-comings of written diagnostic tests

While written diagnostic tests may generally indicate areas of concerns in a student's understanding of mathematics, such tests may not provide sufficient or accurate information on a student's lack of understanding or difficulty in specific areas of mathematical learning. Although the teacher tends to analyze errors found in these tests and hypothesizes the cause of the errors, this form of analysis may be subjected to misinterpretation when educated guesses about students' error patterns are made.

$$\begin{array}{r} 46 \\ \times\ 4 \\ \hline 1624 \end{array} \qquad \begin{array}{r} 47 \\ \times\ 3 \\ \hline 1221 \end{array} \qquad \begin{array}{r} 38 \\ \times\ 5 \\ \hline 1540 \end{array}$$

For example, in the above multiplication sums, teachers may interpret that this student may lack knowledge in place value. However, unless teachers interview such students and request them to explain at how they derive at their answers, the cause of these errors may not be obvious. Furthermore, teachers will not be able to

understand their students' level of comprehension and provide remediation on the specific error pattern.

Student's Response: *"Six times 4 equals 24. So I put down my 4 ones here and carry the 2 tens. 4 tens times 4 equals 160 tens. Then, I add the 2 tens from before and I write down 162 tens here."*

This illustration suggests that error patterns may be hypothesized from written responses in class assignments or tests. One problem is that some exercises are not vigorous enough to provide the teacher sufficient information on the difficulties faced by the student. Thus, exercises may not identify accurately the existing gaps in the understanding of the student. Remedial actions may be hampered in such cases.

Advantages of an interactive cognitive interview

When an interactive cognitive interview is properly sequenced, it provides a wealth of information that can be interpreted by the teacher for remediation. The interview is highly flexible as the teacher adjusts the interview taking into consideration the learning style and personality of the student, the impact on the student's learning process, the appropriateness of the language and the level of content difficulty. Through the interactive cognitive interview, teachers are able to observe and identify students' cognitive strengths, weaknesses and affective needs immediately. Furthermore, questions posed can be modified or restated more appropriately for the student in question. Hence, content validity is guaranteed as students demonstrate their understanding. Students can also be given many opportunities to demonstrate understandings of different skills and procedures with concrete or manipulative objects or through modelling the process skills with a possibility of devising a sequential plan of attack or protocol to suit the student's own learning style and personality.

The Interview Process

According to Long and Ben-Hur (1991), interview processes involve four components: the initiation, the formulation of hypotheses about the student's understanding, the testing of these hypotheses through questioning and to ascertain which methods and materials are best suited to enhance the knowledge of the student.

In the initial stage, rapport between the teacher and the student must be built so that the student will be comfortable and ready to participate and attend to the teacher's line of questioning. At this stage, the teacher needs to orientate the student by explaining that the purpose of the interview is to help them learn more effectively and this may justify any recording or videotaping used.

Once the hypothesis has been formed, the teacher is encouraged to question the student to assess the level of their mathematical understanding. The student should be encouraged to rephrase, elaborate and support their responses with explanations and arguments. At this stage, it is critical that teachers remain nonjudgemental in their responses and at the same time show respect for the student's thinking and curiosity. Long and Ben-Hur (1991) found the following phrases helpful for some teachers:

- I am interested in your thinking.
- Please help me understand. Suppose you are the teacher and I am your pupil. How would you teach me.
- I don't think that this problem is easy. Sometimes I get confused myself, don't you?
- Sometimes when I have difficulties with a problem, I break it down into small steps. Let's do that here and find out ...
- I like it when you take the time to think.
- I understand now, but ...

As this stage requires indepth questioning to probe on student's language and ability on the given task, essential interview strategies advocated by Liedtke (1988) are found to be extremely useful.

Essential Interview Strategies

The following strategies could be incorporated:

1) **Illustration:** This involves asking the students to redefine a concept or operation in more concrete terms (e.g. demonstration, modelling, think-aloud as well as involving multi-sensory approach). Illustration of understanding as far as possible should also include speaking, writing, listening, identification and manipulation.

Examples:

a) "Write down twenty-four plus eighteen". (This is to observe for reversals, alignment and proper concept numbering. This activity involves listening and writing).

b) Present a flashcard with the numeral and ask the student to say the numeral's name.

E.g. i) Show flashcard [11], student to say "eleven".

c) Say a number name and ask student to select its digit from digit cards 0 – 9. Set out digit cards in random arrangement.

d) Determine if student is able to provide the relevant number of objects expressed verbally.

E.g. i) Give me five pens.
ii) Put seven pencils in that box.
iii) Place ten books on the table.

2) **Redirection:** If students find difficulty in understanding, there is a need to rephrase or redirect the question. Questioning procedures should enforce scaffolded instruction through probing, cueing or questioning on related steps taken to address the level of students' understanding. Similarly, the student may be asked to answer another question of related nature to assess their comprehension level e.g. 13 – 7 = ☐ from a horizontal format to a vertical format or to compare the equation and the answer to 23 – 7 = ☐

3) **Generalization:** Opportunities for transfer and generalization through the use of varied activities and across different subject domains or learning situation should be included to ensure that there is application of learning.

4) **Questions:** Appropriate planning of different types of questions asked may be crucial as they are likely to affect the student being interviewed and determine the success of the interview. For example:

What about now?
Are you sure?
Look carefully.

Look again.
Think carefully.
Explain it to me again.

In the next section, examples of well-phrased questions are used to seek information and reduce unnecessary written tests on various mathematical concepts.

Understanding of operations

i) Read "this" for me. [8 – 5].

(This is to ensure that the students can identify the numerals and symbols concerned).

ii) Do you know other ways of reading "this"? [8 – 5]

(The symbol, " – " may mean subtract and not minus to the student or the student might not realise that the symbol also meant "take-away", "difference" etc.)

iii) Use your counters to show the meaning of [8 – 5].

(This is to ensure that the concept of subtraction is clear).

iv) Make up a word problem for [8 – 5].

v) Show me how you would teach your friend to find the answer to [8 – 5].

vi) Use these pencils to show how you would find the answer for [10 – 3].

Knowledge of Basic Facts

i) What is the answer for 5 x 0?

ii) What is the rule for finding the answer when a number is multiplied by zero?

iii) Use the rule for 8 x 0.

(This is to ensure that the student is able to apply the rule.)

iv) Give the answer for 6 x 1.

v) What is the rule for finding the answer when a number is multiplied by one?

vi) Use the rule for 23 x 1.

Understanding of algorithm

i) Show me how you would show the answer for 37 – 15 = _____ to me as you are doing it.

ii) Explain to me what you are thinking as you find the answer 41 – 28 = _____.

iii) Show me how you would explain 43 – 16 = _____.

iv) Use these blocks to show how you would find the answer for 403 – 56 = _____.

v) How do you check that your answer is right?

Through the interview strategies, the teacher is then able to identify in an increasingly analytical way the difficulties the student confronts and thus able to plan and set realistic goals for specific intervention programme to assist the student overcome his or her learning difficulties.

References

Liedtke, W. (1988). Diagnosis in mathematics: The advantages of an interview. *Arithmetic Teacher, 35(1),* 26-28.

Long, M. J. & Ben-Hur, M. (1991). Informing learning through the clinical interview. *Arithmetic Teacher, 38(6)*, 44-46.

Silbert, J., Carnine, D. & Stein, M. (1997). *Designing effective mathematics instruction: A direct instruction approach.* New Jersey: Prentice-Hall, Inc.

Vance, J. H. (1986). The low achiever in mathematics: Readings from the Arithmetic Teacher. *Arithmetic Teacher, 33(1),* 20-23.