Error Based Activities in Mathematics Education

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In this article, the researcher will briefly try to introduce this constructivist-based method named error-based activities (EBA) defining errors, misconceptions, and fallacies as the chances for learning and regards these (errors, misconceptions, and fallacies) as positive parameters in the learning-teaching process.

Error- based activities (EBA) are the methods aiming to internatilize the concepts and to provide depth for concepts through errors and mistakes rather than looking for a solution after encountering a mistake, an error, or a problem, or to correct the error or mistake. EBA method can be expressed as a method to create mental confusion by using outside the usual correct use without the familiar use of definition, axiom, theorem expression, proof or question solutions and mathematical terms and notations.

No matter which method is used in the course of the lesson, EBA could be used with a chosen instruction method and also it could be built to this method. The correct information or knowledge related to the concept should be presented while EBA is implemented. Then, mistakes are presented to provide depth in the concept and to clarify the points that are not understood. Because, EBA advocate knowing the mistakes and errors related to the correct information in addition to the correct information in order to fully construct the information. In fact, what is done with EBA is what should and should not be done by sensing the truth is to try to ensure the real sense of learning. In this case, errors play an instructive role, making them important and even necessary.

Error-based activities deal with the process of approaching the concept in a wrong way, diagnosing and treating this error by individuals without the need for any mistakes or errors. It is noted that the mistakes made in EBA application are those aiming to deepen the knowledge. Consciously, the conceptual errors that are attempted to be made in particular, and the use of errors that are inspired by previously misconceptions shape the EBA process. In EBA, mistakes are used in addition to the correct information without waiting for the student to make mistakes or having misconceptions. This method developed based on constructism and considered as error based activity, differs from the other methods interms of the use and application of errors made consciously. In EBA, the basis is on learning from errors in addition to correcting the error. EBA can be assembled in most teaching methods, in terms of time, space, equipment, economic and even fun and can be used in a way that makes you think, and can be used easily inside and outside the classroom.

Implementation

The phases of the EBA implementation process framework were established as follows:

0. Prepare/Preparation Phase: The process of preparing lesson plans based on errors related to the subject before the lesson.

1. Present/Presentation Phase: The process of teaching the subject or concept by any method (the desired method can be used), ie the process of the course according to the selected method. Error-based activities can be implemented in certain time periods with the appropriate methods. In this process, the error should be given after giving the correct information and the issue should not be started with the error.

2. Ask/The phase of asking questions: Process of questioning (conceptually qualified) related to topic or concept. The problem should be instructive.

3. Solve / Solution Phase: The process by which students individually solve/answer the question before giving the solution including errors.

4. Make error/ The phase of a solution including errors: The process of solving the problem including errors.

5. Discuss / The phase of Discussion: The process of discussing the solution including errors with the students without telling the students that they are wrong.

6. Evaluate/Evaluation Phase: The process of evaluating the student responses through carefully monitoring them. Errors, original ideas, and different approaches that may arise while answering during the discussion are noted. In addition, students' own solutions made in the third stage are also considered here. The cause of the error and the correct answer are not given. Student responses are evaluated and their approaches to error are determined.

7. Final remarks/ Explaining the right answer with its cause: Before the next lesson, the reason for the error is explained and the correct answer/solution is given after the students' ideas are briefly taken again.

Example of Implementation

In the classroom environment for EBA implementation, for example, the EBA implementation process stages related to the topic"Simple inequalities"one of the topic in 9.grade Number and Algebra Learning Domain, Equilities and Inequilities Sub-Domain can be implemented as follows:

0. Prepare/Preparation Phase: Preparing error-based questions about the part to part operation on simple inequalities. The operation word evokes correlation and function. Equality refers in some cases to function, in some cases to correlation while inequality necessarily indicates correlation.

1. Present/Presentation Phase: In a course of mathematics focusing the subject of simple inequalities, whatever the method used in the course (presentation, invention), the relevant definition, theorem, the rule are presented and necessary examples are solved.

2. Ask/The phase of asking questions: After the presentation of the subject is completed and the examples are solved and made the students solved, a similar example is given as follows and the students are asked to solve them. "*If $x \in R$ and -2 < x < 3, what interval is 2x?*"

3. Solve/Solution Phase: Students do their own solving first.

4. Make error/The phase of solution including errors:

$-2 < x < 3 \Rightarrow -6 < 3x < 9 \wedge -3 < -x < 2$

and when these statements are collected side by side;

$$-6 < 3x < 9$$
$$\underline{+ \quad -3 < -x < 2}$$
$$-9 < 2x < 11$$

5. Discuss/The phase of Discussion: Although this error based solution does not contradict any given rules, the process of discussing with students why such a result has been reached begins. Here, the students should also consider their own solutions. Here, students are never told that the solution has error. If the students accept this solution without any reaction, the teacher comes in and directs the students to re-examine the solution. If necessary, offers the following solution as an alternative solution:

$- 2 < x < 3$ when each side of the inequality is multiplied by 2;

$$- 2 < x < 3 \Rightarrow - 4 < 2x < 6$$

found. Or

$-2 < x < 3 \Rightarrow -10 < 5x < 15 \land -9 < -3x < 4$

and these statements are added side by side;

$$-10 < 3x < 15$$
$$\underline{+ \ \ -9 < -x < \ 4}$$
$$-19 < 2x < 19$$

there found a different interval as above.

The reason of the error is discussed in the classroom, even if the students correctly explain the reason for the error, the teacher does not approve it and does not give the correct answer until the following lesson. It should be noted that the rules of simple inequalities are correctly implemented in this solution. This emphasis must be made in discussions. In the case of simple inequalities, it is particularly emphasized in the sources that the rule of side by side addition can be applied but side by side subtraction cannot. It may be desirable to investigate the cause of this error and write down ideas outside of school.

6. Evaluate/Evaluation Phase: Student responses are carefully monitored and errors, original ideas and different approaches that may arise during the discussion are noted. Student responses are evaluated and their approaches to error are determined. The cause of the error and the correct answer is not given.

7. Final remarks/ Explaining the right answer with its cause: Firstly, the reason for the error is explained after the students explain ideas are briefly. When expressing this contradictory solution, it is emphasized that a variable can have the same value at the same time. For example, on the left side of the $-6 < 3x < 9$ inequality and $-3 < -x < 2$ inequality expressions, the variable x takes a value very close to both -2 and 3 at the same time and these different values are added as if x is the same at the same time. Again, the students must see that they cannot do this in the process of addition in the concept of relations they constantly encounter here.

Considering the equation $f(x)+g(x)=(f+g)(x)$, where $f(x) = 3x$ and $g(x) = -x$ are considered; the sum of the $f(-2)+g(3)$ implemented at the same time. In this case,

$$f(-2)+g(3)=(f+g)(?)$$

whether the number -2 or number 3 should be written instead of the question mark in above function? The meaning of the concept of variable, relations, functions are emphasized as seen here on the conceptual basis of the error.

As a result, error-based activities can be seen as an economical and convenient method that can be used easily not only in mathematics education but also in physics, chemistry, biology and social studies education.

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