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Teaching & feedback practices for enhancing mathematical skills: Some field experiences

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Abstract
Mathematics is taught in school to enhance cognitive skills like problem solving, reasoning, critical and rational thinking. These skills can be improved only if opportunities are given through meaningful classroom student-teacher interactions and through feedback given for tasks assessed. The Mathematical skills can be enhanced if teachers use inductive approach of teaching. Inductive approach of teaching will provide opportunities to the students for enhancing their Mathematical skills. These skills can also be enhanced when feedback is given for formative tests and activities. The Formative assessment activities given in CBSE schools are both written and performance based. This implies that teaching Mathematics with inductive approach and appropriate feedback given for Mathematics FA activities would enhance Mathematical skills. This paper aims at finding out the instances used for teaching mathematics in class IX, criteria-based feedback given to the students Mathematics teachers, and the type of feedback given to the students by the Mathematics teachers. For this study Eight Mathematics classes were observed in 5 different CBSE schools. The number of Mathematics teachers whose classes were observed were five, total number of class IX students in five schools were 180. The findings show that inductive approach of teaching was used in the topics related to geometry where it was easy for the students to imagine the diagram like parallelogram and quadrilateral. Many (43.75 percent) teachers gave task specific criteria for formative assessment. Large number of (50.76 percent) students were not given any comment for improving their wrong answers in the notebooks or the test sheets. Large number of low scorers (73.84 percent) were given common feedback, no separate feedback for improving their scores were given.

Keywords: Mathematics, CBSE, practices, Teaching

Introduction
School education plays a vital role in enhancing the learning abilities and skills of a student through two important process assessment practices and teaching learning process. Out of all the school subjects Mathematics has much scope to enhance cognitive abilities like problem solving, reasoning and thinking in the students. These abilities through Mathematics teaching can be improved if taught with an inductive approach. Shaffer (1989) [10] checked effects of inductive-deductive methods in teaching Mathematics on two different groups and concluded that an inductive method was much better than the deductive approach to enhance all ability levels. Silas (2012) [11] Inductive method of teaching model is found to be more effective for teaching circle geometry and trigonometry. Since inductive approach of teaching Mathematics was proved to be impactful for improving cognitive skills like problem solving, reasoning and critical thinking, this study aimed at finding out the instances in Mathematics classes where the scope for any one step of inductive approach is given to the students.

Assessment is another process in school which would help gathering data to better understand the strengths and weaknesses of student learning (Harris and Hodges, 1995) [6]. Assessment also makes the teachers aware about the effectiveness of teaching strategies and barriers underlying it and also gives an idea about the cognitive level of the students. If the assessment outcomes are utilized to give feedback to the students then it may motivate the students to improve learning inturn leading to improved achievement. Academic feedback is more strongly and consistently related to achievement than any other teaching behaviour (Bellon, 1991) [2]. Thus, for student's feedback based on assessment will help in self- monitoring their performance and self-regulated learners (Nicol and McFarlane-Dick, 2006) [7].

So, it can be implied that assessment should integrate grading, learning, and motivation for the students. The introduction of Formative assessment by CBSE was to assess the students on different type of tasks and give feedback to improve learning. The teachers were to use different tasks like pen paper test, assignments, model making, presentation, group work and other such tasks for assessment of the students formatively. The pen paper test gave feedback to the students when marks were shown but the performance-based activities were to be assessed on certain criteria.

Context of Teaching and Assessment in Mathematics for the present study
Teaching and Assessment are two integrated processes which should provide enough opportunities for the students to enhance their cognitive abilities. Cognitive abilities in context of Mathematics will include problem solving, critical thinking and reasoning. The main aim of introducing formative assessments by CBSE in the year 2009, was to continuously give feedback to the students for improving their learning and also to enhance different abilities. Its aim was also to enhance the teaching learning process with integration of more learner centered methods and activities

so that the cognitive abilities can be improved. Thus, teaching and feedback on assessment are both important for enhancing cognitive abilities.

Inductive approach to Mathematics teaching: A boon to improve cognitive abilities

Inductive approach proceeds from particular examples to general rules of formulae, concrete illustration to abstract rules, known to unknown and simple to complex. Inductive approach of teaching has a psychological impact which enables as child to actively in volve in learning by arousing his/her ability of "perceiving" (Atta, 2015) [1]. Inductive approach of teaching Mathematics helps students to recognize design patterns from within the practice and develop the thinking and curiosity of the students (Nicole, 2007). Moreover, researches also show that inductive approach of teaching Mathematics is better than the deductive approach of teaching (Shaffer, 1989; Silas, 2012) [10, 11]. Zdravko Kurnik (2008) [12] "a Math teacher need not be a scientist in order to apply the science principles and scientific methods in teaching. Solving a Math problem implies some research and development and this work can be done by using inductive method. By using inductive method, a teacher can create the spirit of curiosity in his students, the inclination for independent mental work and to show them ways to new discoveries."

Inductive approach of teaching has four steps Presentation of Examples, Observation/Reflection, Generalization (Simplification), Testing and verification (authentication). The teacher has use all four steps in a serial manner, but sometimes any one or two steps are also used by the teachers. In the present study the Mathematics classroom interactions were observed to find out presence of anyone step of the inductive approach.

Significance of Academic feedback based on assessment

Academic feedback is more strongly and consistently related to achievement than any other teaching behaviour (Bellon, 1991) [2]. Black and William (1998) "conclude that regular and appropriate feedback to students regarding their learning process may effectuate significant learning gains."

The use of appropriate feedback to improve abilities and learning is possible when feedback is given continuously for formative and summative assessments both. Continuous assessment introduced by CBSE in 2010 meant regular assessments, frequency of unit testing, analysis of learning gaps, applying corrective measures, retesting and giving feedback to teachers and students for their self-evaluation through written formative tests and formative activities (CBSE Teachers Manual, 2010). So it can be said that formative assessment concerns how to improve students' competences by communicating judgments regarding the quality of the students' responses to tasks (Sadler, 1989) [9]. Appropriate formative assessment will help identify learners' mathematical problems and cognitive problems so that proper interventions can be done (Clarke & Shinn, 2004) [5]. However, students will feel the feedback is effective only if three factors are present: credible feedback provider, timeliness of the feedback, and the type of delivery of the feedback (Poulos and Mahony, 2008) [8].

This study aims at finding out the appropriateness and the feedback given for the performance based formative activities in terms of the criteria of assessment used by the teachers; timeliness and type of feedback given based on the written formative tests in Mathematics.

Objectives of the study

1. To identify the use of inductive approach of teaching instances in Mathematics classrooms
2. To study the feedback given to students for performance based formative activities
3. To study the feedback given to students for formative written tests

Delimitation

The study was delimited to the IX standard students (academic year 2017-18) of CBSE affiliated schools in Vadodara district.

Population

Total 22 teachers who taught Mathematics in class IX of 17 CBSE schools in Vadodara district and the 2190 students studying in class IX of CBSE schools of Vadodara District formed the population of the study.

Sample: Total 4 schools were selected for gathering the data

Total 8 Mathematics teachers who taught Mathematics in class IX of 4 CBSE schools in Vadodara district formed the sample of the study. All the class IX 65 students studying in class IX of 4 CBSE schools of Vadodara district selected randomly, formed the sample of the study.

Design of the study: This study was a descriptive survey.

Tools and Techniques used for the study

Questionnaire for the teachers: A questionnaire with both close ended and open-ended items was made by the investigator to gather information about the assessment of performance activities and written tests.

Non-participant Observations: Non- participant Classroom observations were done in 8 Mathematics classes 4 different CBSE schools of Vadodara district.

Semi-structured interview for the students: A semi-structured interview schedule was made with both close ended and open-ended questions was developed by the investigator to gather information about the feedback given to the students on the written tests.

Data gathering procedures: The responses about the type of feedback given on written formative test students; of 17 CBSE affiliated schools in Vadodara district. Responses of randomly selected 16 Mathematics teachers out of 22 Mathematics teachers in the 17 CBSE schools was also collected through was gathered through a semi structured interview of randomly selected 65 students out of 2190 class IX a questionnaire to know about the criteria-based feedback given on performance-based FA activities. Total 8 Classroom Observations of Mathematics teachers teaching in five randomly selected schools were conducted to see instances of inductive approach used for teaching. Data gathered was qualitatively analyzed using content analysis and quantitatively analyzed using frequency and percentage. In the findings the teacher responses are denoted by R1, R2 R8.

Data analysis

In order to get the findings, the data were qualitatively and quantitatively analyzed. For objective 1 the classroom observation instances are indicated as of the study like O1 (observation 1), O2 (observation 2), O3(observation 3) and

O4 (observation 4) has been analyzed qualitatively and has shown below. A total of 6 mathematics classroom observations were done. The observations are presented below in the verbatim form. The feedback criteria given by the teachers for various formative assessment tasks or the performance based tasks has been described using the indicators like R1 (Response 1), R2 (Response 2), R2 (Response 2), R3 (Response 3), R4 (Response 4), R5 (Response 5), R6 (Response 6), R7 (Response7) and R8 (Response 8) and its appropriateness has been drawn to write the findings. To draw out the findings of the objective 2, qualitative analysis has been done. The objective 3 was to find out the type of feedback given on the written tests. In order to gather the findings, the data for objective 3 was analyzed quantitatively using frequency and percentage.

Objective 1: To identify the use of inductive approach of teaching instances in Mathematics classrooms

In two classes out of eight, the inductive approach was seen in terms of just giving the students the opportunity to reflect/observe on the given things and think what should be the next step to solve the Mathematical problem. In class I there were three instances (O1;O2 ;O3). In another class (class2) there was only one instance of inductive approach was shown. The instances are described below

Class 1

O1

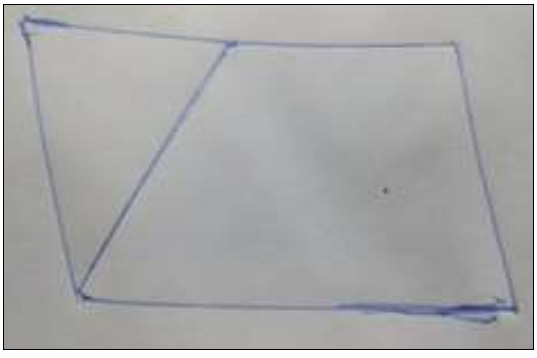
Teacher: (teacher asked the students to observe the diagram of the rocket) which are the geometrical figures seen.
Student1: trapezium and isosceles triangle
Teacher: does the trapezium and isosceles triangle have the equal sides?
Student 2: Yes
Teacher: then find the area of trapezium and isosceles triangle (students started writing the given measures and tried to find the area of both and got the correct answer also)

O2

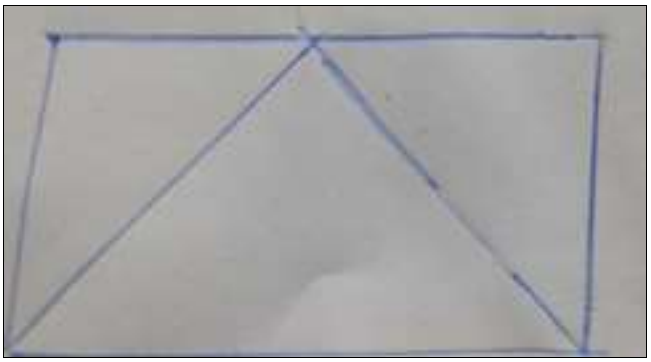
Teacher: Drew a trapezium and told that it is a combination of equilateral triangle and rhombus. Now how will you find the height of the triangle from the measures given for the sides of a rhombus. (teacher asked them to discuss with their group and tell the method)
Student 1: Solved the sum and showed the height of equilateral triangle.

O3

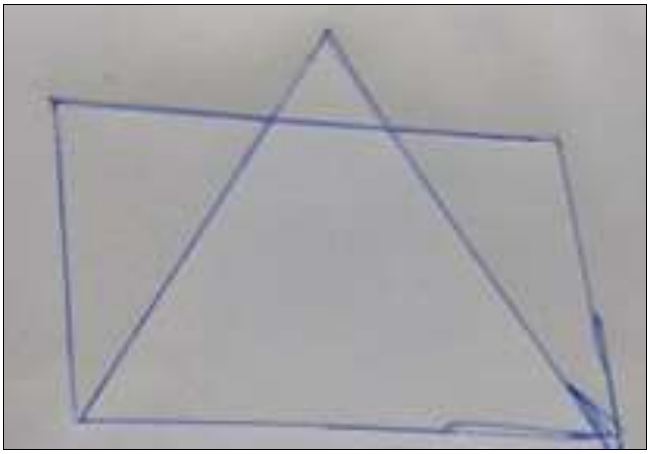
Teacher: If area of a parallelogram and a triangle are same. Draw as many as diagrams as you can?



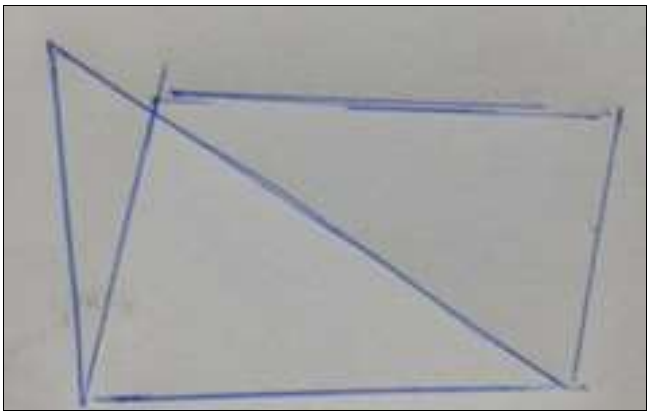
Student 1



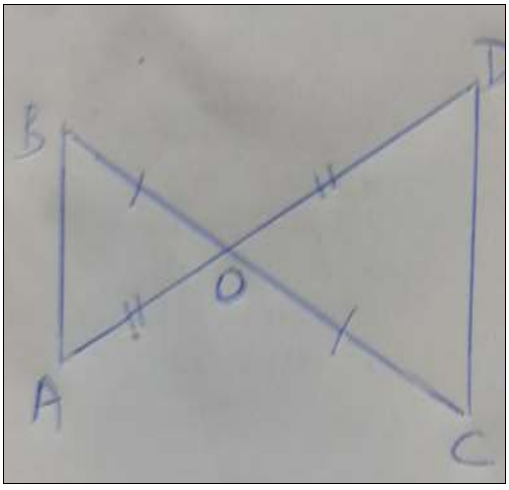
Student 2



Student 3



Student 4



Student 5

Class 2

Teacher: teacher drew the following diagram and asked the students to prove BC>AD

Student1: OB+OC=BC and OA+OD=AD

If ∟A>∟B

OB>OA----- (i)

∟D>∟C

OC>OD---- (ii)

Student 1: So OB + OC>OA+OD

So BC>AD

Out of the 8 classes observed

1. In the above two classes the students were given the opportunity to observe and reflect so they involved them fully and the class also became interactive.
2. It was observed that two classes with inductive approach the students were active six classes with deductive approach the students were passive and just noted down the things from the board.

Objective 2. To study the feedback given to students for performance based formative activities

1. Out of 16, five teachers (31.25 percent) gave the same criteria for assessing all the performance-based activities like chart making, solving extra sums or making a power point presentation like accuracy, problem solving and presentation, time management skills.
2. Seven teachers out of 16,(43.75 percent) Mathematics teachers, gave different criteria of assessment for different activities.

The criteria of assessment given by the seven teachers are given below with the name of the activity.

R 1 & R7: research topic: content, relevance, originality, presentation and timely submission.

R2: integrative project: clarity of the content, presentation, viva, calculations accuracy and imagination.

R3 & R6: Maths laboratory activities: concept clarity, correctness of the answer, observation and conclusion

R4: Statistic project was assessed based on the following parameters: originality, presentation/neatness, abstract, description and justification.

R5: Evaluating problem solving: accuracy. For evaluating Maths lab activity: accuracy, time management

R8: Power point of surface area and volume of cube, cuboid, cone, cylinder, sphere and hemisphere- criteria of assessment: presentation (3marks), content (3marks), technical co-ordinator (3marks) and team co-ordination (2marks).

3. Four teachers out of 16 (25percent) teachers did not use any criteria for assessment of performance-based activities
4. All the 12 teachers who used criteria for assessing the performance-based activity said that criteria were used to only grade the students and not to feedback them.

The above findings show that there were large number of teacher's 43.75 percent teachers who gave appropriate criteria for assessing different formative activities which is quite good. While though few but 25 percent teachers did not give criteria-based assessment which defeats the aim of formative assessment.

Objective 3. To study the feedback given to students for formative written tests

1. Total 33students (50.76percent) said that no comments were written for wrong answers only they were marked wrong and that it was up to the students to go to the teachers and find out why the answers were wrong or what were the missing points in their answer
2. 22 students (33.84) said that teachers wrote comments for improvement; 8/65 students said that teachers wrote the incomplete points in their answer books for them to understand.
3. 8/65(12.30) students said that teachers wrote the incomplete points in their answer books for them to understand
4. Total 17 students out of 65 (26.15percent) said that the teachers called the low scorers separately and explained them their mistakes and gave suggestions for improvement
5. Remaining 48 students (73.84 percent) said that low scorers were either not given feedback separately

Major Findings

In order to write the findings of the quantitatively analysed data the following norms were used. The norms were used to write the findings of objective 2& 3 which were about the feedback on performance-based activities and the written tests respectively.

Few: responses from the data source is less than twenty percent

Some: responses from one data source is from twenty one percent to 40 percent

Most: responses from any one data source is Forty one percent to Sixty percent.

Majority: responses from any one data source is Sixty one percent to 99.99 percent.

All: Hundred (100) percent.

1. out of the six classes there were only two classes where inductive approach of teaching mathematics was used
2. In six classes only deductive approach was used for teaching Mathematics
3. Some Teachers (31.25percent) gave the same criteria for assessing all the performance-based activities like chart making, solving extra sums or making a power point presentation i.e. accuracy, problem solving and presentation, time management skills.
4. Most of the Mathematics teachers (43.75 percent), gave different assessment criteria appropriate for each activity.
5. Some teachers (25percent) did not use any criteria for assessment of performance-based activities
6. Majority of the teachers (75 percent) used assessment criteria only for grading the students and not to feedback them.
7. Most of the students (50.76percent) didn't get written comments for writing wrong answers they wrote
8. Some students (33.84 percent) got written comments for the wrong answers from teachers, which was a feedback for enhancing their improvement.
9. Few students (12.30 percent) got the missing points written for their incomplete answers in their answer books for them to get better feedback
10. Some students (26.15percent) said that the teachers feedback low scorers separately and explained them their mistakes and gave suggestions for improvement in

written test

11. Majority of the students (73.84 percent) said that low scorers were not given feedback separately so that they can improve their performance in written test.

Conclusion

The findings show that though there were only two teachers out of eight who tried to implement inductive approach of teaching mathematics the results were positive in terms of student involvement and active participation. The teachers just had to be open to the different responses given by the students and they were ready to give all possible answers and methods to solve the problems posed. It is a positive thing that 43.75 percent teachers have different criteria for assessing different formative activities. But the purpose of criteria-based assessment to provide feedback to the students so as to improve their abilities was not fulfilled, this shows that the teachers used the criteria only for grading the students and not for improving the students cognitive abilities. The criteria given by teachers for assessing different activities seems to be apt but if it was not used to feedback students, it would have helped in enhancing cognitive abilities. The low scorers in the written tests should be given personal feedback for their improvement but majority of the student responses (73.84 percent) show that student low scorers were not given feedback separately, so the aim of formative assessment to give feedback for improvement has been addressed lesser extent. It can be concluded that the formative assessments of performance based and written tests were done by majority of the teachers but as the teachers did not use the formative assessment to feedback the students to improve their cognitive abilities. This may be due to the lack of orientation to the teachers about the purpose of formative activities or the lack of interest of the teachers to feedback students. Hence if the student's cognitive abilities have to be improved through feedback the teachers should be orientated about its purpose and the implementation should be ensured.

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