

GOOD MATHEMATICS TEACHING PRACTICES - IN THE MAKING: A PHILIPPINE EXPERIENCE

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This paper discusses how an eighth grade mathematics teacher engaged his students in hands-on activities, made them work on tasks in small groups, encouraged them to solve problems in different ways, and seized their mistakes as learning opportunities. Although the way he carried out these teaching practices still requires much improvement, these enabled the students to make sense of mathematics by discovering mathematical relationships on their own, communicating their ideas and reasoning logically, exploring various ways of solving problems, and regarding making mistakes as part of learning. These experiences put the students as the most important factor in the teaching-learning process. Such is a big departure from the traditional classroom scenario where the teacher is the source of all learning.

A CONTEXT FOR GOOD MATHEMATICS TEACHING PRACTICES

In order to understand what good mathematics teaching practices mean in relation to the class described in this paper, it is necessary to know the characteristics of mathematics classes in the Philippines generally, the recommendations of the Department of Education on strategies in teaching mathematics, and the perceptions of key mathematics teachers regarding effective teaching strategies. Likewise, it is important to know the methodology used to gather data that captured these good practices.

What is a Mathematics Class in the Philippines Like in General?

To a great extent, the teacher explains and asks questions in a whole class setting. If group work is done, it is superficial. When students discuss, they seldom can sustain the discussion and make it productive (Pascua, 1993). Students are orderly and quiet. To begin a new topic, the teacher first asks students what they know about it then explains the definition and rules (Department of Education, et al 2000). The most common strategies in teaching mathematics are exposition, practice and consolidation, and discussion (High School Mathematics Education Group 1996; Bernardo, Salazar-Clemina, and Prudente 2000).

Department of Education's Recommendations and Key Teachers' Perceptions

The 2002 Basic Education Curriculum in Mathematics in the Secondary Level which is currently being implemented advocates using a variety of teaching strategies among which are practical work, discussion, problem solving, investigations besides

exposition and practice and consolidation, as well as cooperative learning (Department of Education 2002).

The teaching strategies perceived to be most effective by science and mathematics teachers of schools identified as benchmarks in teaching and learning practices were: hands-on experience that brings students to their fullest learning capacity because they depend on themselves, cooperative learning because they can share better knowledge when they work in groups rather than when they work alone, and self-discovery because it enhances students' learning capability (Penano-Ho 2004).

How were the teaching practices documented?

The source of data in this paper is the 21st section of a grade 8 mathematics class consisting of 57 students in a public secondary school in Metro Manila. It was one of the three Philippine schools included in the international research Learner's Perspective Study which focused on the teaching and learning process that went on in grade 8 mathematics classes taught by locally identified competent teachers. The class was observed and videotaped for 15 consecutive school days with the first 5 days serving as familiarization period. Three cameras were used: one focused on the teacher, another on the whole class, and still another on two focus students who were randomly selected daily. There was on-site mixing of the teacher and focus students' cameras. A microphone placed between these students picked up their conversations. At the end of each class that lasted on the average for one hour, the focus students were interviewed one after the other. The teacher was also interviewed at the end of each week. The video-stimulated interviews were audio-taped and along with the mix videotapes transcribed. Translation was done when needed because although English is the medium of mathematics instruction, both the students and the teacher at times code-switched to Filipino, the national language. This paper used the data from the mix videotapes, teacher interview, and lesson plans for the last 9 days. The lessons were on geometry, particularly conditions for right triangle congruence, quadrilaterals and their properties, and different kinds of parallelograms and their properties.

GOOD TEACHING PRACTICES

A typical mathematics class usually employs the question and answer type of exposition, the teacher starts with definitions and rules, and students are most of the time quiet and just listen to the teacher. In contrast, the teacher in this study used hands-on activities for practical work to introduce a topic and elicited discussion among students when they worked in small groups, presented their various ways of solving problems, and corrected their mistakes.

Using Hands-on Activities

In 2 of the 9 lessons, the teacher used practical work besides exposition. In lesson 8, instead of giving the definition of a median and altitude that will be used in a subsequent construction of a proof, he asked the odd-numbered groups to draw any

triangle and a segment from any vertex to the midpoint of the opposite side. He also asked the even-numbered groups to draw any triangle and a segment from any vertex perpendicular to the opposite side. This was an instance where not all the students were doing the same task and individually within a group, students were free to choose what kind of triangle they will consider. Later, the teacher asked the students to analyse their work and compare it with their seatmates. If only the teacher did not add that the students may draw an acute, right, or obtuse triangle and left the students to think about this on their own, this could have been an open exploration activity. After a sample answer from each task was presented, the teacher brought out the term median and altitude, the important words that he would use in the lesson. So the activity provided a context in which these two words were introduced and its additional value was that students observed that regardless of the kind of triangles that they drew, the three medians and the three altitudes always intersect at a point and that in fact, a triangle can have three medians and three altitudes or heights. According to the teacher, students usually encounter the word altitude or more familiarly the word height only in formulas. And so here, he wanted them to realize that this is the same height that is involved in proofs. So he tried to make connections from what they had known in measurement to what they were learning in geometric proofs.

In Lesson 11, the teacher used practical work to make the students verify the following relations after they had established the proofs: in a parallelogram, opposite sides are congruent, consecutive angles are supplementary, and opposite angles are congruent. He asked some students to use the blackboard meter stick and blackboard protractor to measure the sides and angles, respectively of his drawing of a parallelogram. Thus, the students had the opportunity to confirm that what holds true for the general case also holds true for a specific case.

Using practical work is a good teaching practice because it enables students to discover on their own abstract relationships through concrete means. By using this, students will take on greater responsibility for their own learning rather than merely rely on the teacher (National Council of Teachers of Mathematics 1989). By providing students with appropriate activities and facilitating the processing of the results, this can be achieved. Perhaps, would-be teachers in teacher education institutions can be taught how to develop such activities especially for topics that students find difficult to learn. They can also be taught how to conduct action research to determine if the strategy really helps in better student learning.

Using Groupwork

A dominant feature of the lessons, that is in 7 out of the 9 lessons, was the use of group work. Since students were organized by tables, those seated around a table consisted one group. Some groups had 9 members while others have 10. In lessons 6 to 8, group work involved performing exercises on making proofs. In lesson 9, there was a test and in lesson 13, the teacher carried out a whole class discussion on the

different properties of parallelograms, so in both lessons there was no group work. In lessons 10, 11, 12, and 14, group work involved exercises on computations.

Working in small groups afforded students opportunities to ask questions intended to get help or clarify their thoughts and to communicate their ideas clearly and reason out logically so that they could be understood whether they were asking or answering questions or simply discussing their ideas.. An example is in lesson 12. The group of Arn and Sher was asked to determine the measures of all the angles of parallelogram CITY given that angle C is equal to $5x - 10$ and angle T is equal to $4x + 10$. Sher wrote their answers on the manila paper which the teacher gave. Following are the conversations of Sher and Arn.

- Arn: How did that happen? Why are I and Y 90?
- Arn: What's this consecutive? Who's going to explain?
- Sher: Arn
- Arn: Consecutive? Consecutive angles?
- Rub: Angle I and angle T?
- Arn: What's that? Supplementary? Are these supplementary? Supplementary?
- Arn: What?
- Sher: What? Which? Which is your problem here?
- Arn: I'm asking if these are supplementary?
- Sher: Supplementary? They are equal because aren't C and T opposite angles?
- Arn: Yes.
- Sher: Opposite angles are congruent, oh. So it's written there, angle C is equal to angle T. $5x$ minus 10 is equal to $4x$ plus 10.
- Arn: Yes.
- Sher: There, then just find their value.
- Arn: Okay. Why does it not have this?
- Sher: What? It's there already, oh.
- Arn: What I mean is, why is it like that? ... Why?
- Sher: There's no more like that because $5x$ minus $4x$ is already x . You don't need to get it.
- Arn: Wait, wait.
- Sher: $4x$. $5x$ minus $4x$ is equal to $1x$, eh we divide don't we?
- Arn: $5x$
- Sher: Minus $4x$.
- Arn: Oh, $1x$.
- Sher: So do you still need to divide $1x$ by 1?
- Sher: Isn't it that you don't need to? Isn't it that it's just the same as x ?
- Arn: Sher...Sher.... Psst, Sher. Eh, what is, what is angle I? Consecutive angles?

Sher: Yes, because C and angle what, angle C and angle I are consecutive angles.

Sher: It means that they are supplementary, their measure is 180.

Arn: Whatever is the measure should they be 180?

Apparently, Arn did not stop asking Sher until he got satisfactory answers to all his questions. Sher patiently explained because Arn would present the work of their group for others had their turn already. In fact, for a while Arn asked Sher to present in behalf of their group because she knew how to do it. Nonetheless, because by asking questions, Arn came to understand their solution, he presented it. This was the kind of support that group members got since the atmosphere was one of cooperation rather than competition. During group work, the teacher went around the room to monitor and assist the different groups. Arn did not have to wait for the teacher to come and help him because somebody in his group was already capable of doing that.

As it was, small group work had already its merits but these were limited. For instance, the group size was too large to fully involve every member in the discussion of the solution. There should had been two smaller groups per table instead of just one. The best student in each group almost single-handedly thought of the solution while the others simply looked on and asked him or her or other group members, if at all, when they did not understand something. The most insistent ones in asking questions were those who would present the group's output. Some groups finished quickly, and so were off-task and sometimes noisy while the other groups were still working. If only the teacher were sensitive to these situations, then he could have converted group work to cooperative learning whose distinctive features are complete participation and individual accountability for knowing what was done (Johnson and Johnson 1990). The benefits of cooperative learning aside from the development of communication skills such as better mathematics achievement and positive interpersonal relationships are well-documented in research studies (Webb 1991, Fitzgerald and Bouck 1993, Pickhard and Bingaman 1993). Hence, if properly implemented as a cooperative learning group, using small group work is a good teaching practice. In the Philippines where classes are big and so the teacher is not always readily accessible for help and where resources are limited, cooperative learning offers peer help and resources sharing.

Encouraging multiple solutions to problems

The teacher also gave the students the opportunity to work on the tasks he assigned the way they decided to. For instance, in Lesson 11, the group of Nic and Jean were asked to find the measure of each angle of a parallelogram MORE given that the measure of angle R is $5x$ and the measure of angle E is $4x$. At the time that they were working on this routine problem, the teacher approached them. The teacher asked them what the relation between angle E and angle R was to which Nic correctly responded "supplementary". When the teacher probed for the reason, members of the group also correctly answered "consecutive." The teacher then told them where to write their solution apparently thinking that they would use the relation that

consecutive angles of a parallelogram are supplementary, to get the value of x . That is, $5x + 4x = 180$. So $x = 20$. On the contrary, Nic said: "Given if measure of angle E is equal to $4x$. Measure of angle R is $5x$. Eh, then ... this. This is $5x$, and $4x$ also (referring respectively to angles M and O)." He made use of the relation that the opposite angles of a parallelogram are congruent and that the sum of the measures of the angles of a quadrilateral is equal to 360. He got $5x + 4x = 9x$. $9x + 9x = 18x$. Then $360/18x = 20$. Substituting the value of x for the measure of angles E and R, he got the measure of each of the angles. Nic later presented their work. After he had presented, the teacher made the following comments.

- Teacher: What can you say about the solution of this group and this group? Is there any difference?
- Student: Yes.
- Teacher: Yes. But you got the same answer, is that right? Let's see. What did you use here Mike? This is your answer Mike. What did you use here? The? Yes, Mar.
- Mar: The...the what. Equal measures.
- Teacher: Measures...Here, here. Angle A and, ah, is equal to $5x$, $7x$. So 5 plus 7 is equal to $12x$. That is? What did you use? ...Mike.
- Mike: Consecutive angles.
- Teacher: Yes, consecutive angles. So what about what about Nic?... You use here?
- Nic: The sum of the quadrilaterals.
- Teacher: Okay, the sum of the measure of angles of a quadrilateral. Here he used many. Angle E and angle O. You know these are opposite angles, aren't they? So $4x$, $4x$, $5x$, $5x$...Although this is quite long, but this is correct. And, and I encourage you to ... ah, to use that kind of behavior. Because if you really cannot think like that immediately, eh then try another what try another method, right? O another way ... in finding the correct answer. O last group?

Later during the quiz, the teacher told the class to use relations so that they could cut down on computations. This shows that while he accommodated the long but correct solution of students he at the same time was quick to point out that there was a more efficient way. This balance between accommodating student responses that may differ from what a teacher expects and making them realize that some ways are better than the others, is a good teaching practice. On one hand, students will get the impression that they are capable of coming up with their own solution to a problem no matter how crude or less elegant it may look and this can build their confidence. On the other hand, it can create an inclination in them to explore other solutions (NCTM 1989). Moreover, given different solutions, they can compare their merits and evaluate which one may be better than the others and identify the reasons for their choice.

Viewing Mistakes as Learning Possibilities

Students' group work output at times had mistakes. For example, in lesson 6, one group made an incorrect statement in their proof. When the teacher was already discussing their proof, and he probed the students concerned about what they meant by the statement, Win said: "Sir we just made a mistake in that statement." Emy who wrote their proof admitted that she really made a mistake.

Teacher: Do you realize your mistake?

Emy: Yes. That's already correct.

Teacher: That's alright with me as long as you see...You don't repeat the same mistake. We just keep repeating. Oh, here do you need to bisect?

Another example is in lesson 14. After Mar presented the work of their group with the class following his presentation and the teacher even writing the numbers that he said, Sher commented on his work.

Sher: Sir angle 1 and angle 2 are not supplementary. They are congruent. {Students cheer.}

Sher: Because what you (referring to Mar) did was to add the two and equate to 180 which should not be.

Teacher: Oh that's right! {Teacher analysed the problem. Students were noisy.}

Mar: Sir all are already wrong.

Class: That was embarrassing! {Students teased Mar.}

Teacher: Yes that is correct. That's okay.

Mar: Sir how?

Teacher: No, no. That's okay.

Class: That's okay. That's okay. That's okay, Mar.

Teacher: That's okay. So angle 1 and angle 2 are really not supplementary. But they are congruent. ... Please do them all again. The last part only. Anyway that is very easy than the other one. Alright, just sit down again there. ...Okay next group, next group.

Mar solved again by himself on his seat. A group mate said that he was pitiful because he was solving alone. His group mates encouraged him by saying that he could do it. When he presented for the second time around, his answer was already correct.

In both lessons 6 and 14, the teacher said that it was alright if students made mistakes. Moreover, he gave them the chance to correct their mistakes thereby turning the situation as a learning opportunity. With the kind of accommodating atmosphere that this manner of responding to students' incorrect responses foster, students would more likely not hesitate nor be afraid to solve problems. Yet at the same time, the teacher admonished the class not to be careless in their responses. For instance in lesson 6, she told the groups: "Do not just write for you have nothing more on which to write. You should think. Think. You should think first." It was observed that

only a small sheet of manila paper was provided to each group on which to write their solution. Apparently, the teacher wanted the students to strike a balance between taking risks that might entail committing mistakes and not being careless. His reassuring words and also that of the class exemplified a learning environment referred to by (Boland 1999) where it is safe to take risks because trust has been developed and risk taking and sharing are valued. As such the way he dealt with erroneous responses of students is a good teaching practice.

WHAT ELSE NEEDS TO BE DONE

While the good teaching practices identified in this paper may still be greatly improved, they are definite attempts to implement the recommendations contained in the curriculum on how mathematics should be taught. They are also in line with what the local key mathematics teachers regard as effective teaching practices which in turn are attuned to the thrusts of the international mathematics community. In particular, the teacher will have to be familiarized more on developing and giving open-ended activities involving practical work. He should be coached on how to form and manage cooperative learning groups to maximize the benefits that may be derived from using them. Both of these may be done by mentoring where a more experienced and knowledgeable teacher serves as the mentor. Thus, at present these good teaching practices are still evolving or in the making.

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