Development of Exemplars in Teaching and Assessment: An Exploration of Solutions to TIMSS-Related Problems in Mathematics

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Abstract

This study aimed to make analyses of the results of Trends in International Math and Science Study (TIMSS) Released Items where samples of test items are shown and to develop lesson and assessment exemplars that teachers can use as guides in teaching and assessment of competencies parallel to those included in the TIMSS. The TIMSS 1999 Grade 8 Mathematics assessment items included cognitive domains of knowing facts and procedures, using routine procedures, investigating and problem-solving, mathematical reasoning, and communicating while the TIMSS 2003 Grades 8 and 4 Mathematics assessment items included cognitive domains of knowing facts and procedures, using concepts, solving routine problem, and reasoning. Results revealed that in the 1999 TIMSS released items, the Filipino learners got overall percent correct of less than 15percent in all the five cognitive domains. Among the five domains, the Filipino participants got the lowest overall percent correct in investigating and problem-solving and in communicating and reasoning. In the 2003 TIMSS released items, the Filipino learners also got overall percent correct answers of less than 15percent in all the four cognitive domains. Among the four domains, the Filipino participants got the lowest overall percent correct responses in solving routine problems, reasoning, knowing facts and procedures, and using concepts. Based on the least learned competencies, lesson exemplars and assessment exemplars were prepared. The lesson exemplars followed the 5E (Engage, Explore, Explain, Elaborate, and Evaluate) learning cycle model and were validated by experts. They were tried out among Grade 8 learners and were revised based on the comments and suggestions of the demonstration teachers as well as shared experiences of the learners. The assessment exemplars were developed parallel to the TIMSS items and administered to the Grade 8 learners. Test result scores show that Grade 8 learners have not acquired the skills

and competencies included in the TIMSS. Results discussed here may use teachers to improve and inform pedagogy and assessments develop inquiry skills among students. Teachers may also try using the lesson exemplars as a guide considering the 5E learning cycle model has shown by research to positively affect students' achievement. Analyses of the items may help the teachers to design instruction and assessments that may expose students to higher order thinking skills. Further, results show how mathematical concepts taught and how assessment items constructed to provide students the context and experiences to develop critical thinking and problem-solving skills.

Keywords: assessment exemplars, Grade 8 Filipino learners, Mathematics competencies, TIMSS results, lesson exemplars

Since 1995, the International Association for the Evaluation of Educational Achievement (IEA) has been conducting Trends in International Mathematics and Science Study (TIMSS) at an interval of four (4) years. These studies "aimed at providing valuable information about students' mathematics and science achievement in an international context". Since then, The IEA made three other studies in 1999, 2003 and 2007. Participants in the assessment study were fourth and eighth (equivalent to second- year high school in the Philippines) grade students.

Among these assessments by TIMSS, the Philippines participated in 1999 and 2003. The table below shows the year when student participants from the Philippines participated in the TIMSS assessment studies.

Table 1

Philippine Participation in the TIMSS

Year	Fourth Grade	Eighth Grade	Number of Countries that Participated	
			Mathematics	Science
1999		√	29 (Eighth grade)	29 (Eighth grade)
2003	√	√	25 (Fourth grade)	25 (Fourth grade)
			45 (Eighth grade)	45 (Eighth grade)

In the TIMSS, all countries were required to draw random, nationally representative samples of students and schools. From the schools that agreed to participate, students were sampled in intact classes. In addition to the assessments, students, their teachers, and principals were asked to complete the questionnaires related to their school and learning experiences. Among the fourth-grade students, "the assessment took approximately 72 minutes to complete while at eighth grade students, the examination took about 90 minutes" (Gonzales, et. al., 2004).

In 1999, results of TIMMS assessment in both mathematics and science showed that eighth-grade students from the Philippines ranked 2nd to the last outperforming South Africa (IEA, 2001). Results of 2003 TIMSS assessment in mathematics showed that fourth-grade students from the Philippines ranked 3rd from the last, outperforming Morocco and Tunisia, while eighth- grade students were 5th from the bottom performing higher than Botswana, Saudi Arabia, Ghana and South Africa (IEA, 2005). On the other hand, results of 2003 TIMSS assessment in science showed that fourth- grade students from the Philippines ranked 3rd from the last, outperforming Tunisia and Morocco while eighth-grade students were 4th from the bottom performing higher than Botswana, Ghana and South Africa (IEA, 2005)

From these results, it is, therefore, imperative to look into our

mathematics and science curriculum regarding content dimension on the subject matter or area to be assessed in mathematics and science and cognitive dimension about the thinking processes that students likely to use as they engaged with the content. This study is anchored on the principle that there should be an alignment of assessment with learning, teaching and content knowledge (Biggs, 1996; Biggs & Tang, 1997) as this can be a basis for claims for the validity of assessments). The objective of this study was to analyze the TIMSS test items where the Filipino learners (eighth and fourth grades) did not perform well and to develop lessons and assessment exemplars for teaching and assessing the skills and competencies not yet developed by Grade 8 learners.

Methodology

Research Design and Method

This is a descriptive study. Specifically, document analysis was used to identify the TIMSS test items where the Filipino learners (eighth and fourth grades) performed low. The TIMSS 1999 and 2003 assessments were used for document analyses. From the identified least learned competencies in Mathematics, the lesson exemplars were prepared. These lesson exemplars modeled how these competencies may be taught to Grade 8 learners. Likewise, assessment exemplars were also prepared. These assessment exemplars are parallel to the TIMSS items where our Grade 8 learners performed least. The lesson exemplars were validated by experts was administered among Grade 8 learners and were revised based on the comments and shared experiences of the learners, the demonstration teachers and the observers. The assessment exemplars were administered among Grade 8 learners to determine whether the skills and competencies covered in the TIMSS were developed by learners.

Two workshops were conducted by experts in Science and Mathematics education. One The first workshop was conducted on November 4-6, 2016 which involved preparation of lesson exemplars in Science and Mathematics based on the identified difficulties in TIMSS, revision of lesson exemplars for those that have been prepared earlier, and preparation of assessment exemplars in Science and Mathematics.

The second workshop was conducted on June 28-30, 2017 which involved validation of lesson exemplars in Science and Mathematics based on the identified difficulties in TIMSS, revision of lesson exemplars ready for try-out first semester of AY 2017-2018, and validation and revision of assessment exemplars in Science and Mathematics ready for try-out for the first semester of AY 2017-2018.

The participants

The participants for the try-out of the lesson and assessment exemplars were all the Grade 8 learners at West Visayas State University Integrated Laboratory School. The try-out teachers for the lesson exemplars were the Science and Mathematics student teachers. The observers during the try out were all the researchers and the cooperating teachers of the Science and Mathematics student teachers of the Grade 8 learners.

Data Gathering Instrument

An observation guide was used during pilot of the lesson exemplars. It was face and content validated by experts. The observation guide is shown in Appendix A. The data gathered from the observation were used to improve the lesson exemplars.

Results and Discussions

The 1999 Grade 8 Mathematics (IEA, 2001)

The 1999 Grade 8 Mathematics assessment items included content domains of fractions and number sense, algebra, measurement, geometry and data representation, and analysis and probability. Likewise, it contained cognitive domains of knowing, using routine procedures, investigating and problem-solving, mathematical reasoning, and communicating. Table 2 shows the items in the 1999 Grade 8 Mathematics where Filipino learners performed very low.

Table 2

*Items in the 1999 Grade 8 Mathematics where Filipino Learners Performed Very Low**

Content Domain	Topic	Cognitive Domain	Overall % Correct*	Lowest % Correct
Fractions and Number Sense	Fraction of a circle shaded	Knowing	10%	6%
Fractions and Number Sense	Division of fractions	Using Routine Procedures	11%	4%
Fractions and Number Sense	Shade in 3/8 of squares in grid	Knowing	11%	7%
Fractions and Number Sense	Write decimal as fraction	Using Routine Procedures	12%	3%
Fractions and Number Sense	How much money left if spent 5/8	Investigating and Problem Solving	4%	1%
Fractions and Number Sense	Number/fraction of 2 types of boxes	Investigating and Problem Solving	2%	1%
Measurement	Ratio of width/ perimeter in rectangle	Investigating and Problem Solving	8%	8%
Measurement	Area of rectangle inside parallelogram	Investigating and Problem Solving	6%	3%
Geometry	Measure of angle in quadrilateral	Investigating and Problem Solving	13%	13%
Geometry	Right triangles to cover rectangle	Using Complex Procedures	15%	12%
Data Representation, Analysis, and Probability	Cheaper magazine subscription	Communicating and Reasoning	3%	1%

Note: * The Philippines belongs to the lowest 3 or the overall Percent Correct on the item is 15% or lower

Results revealed that in the 1999 TIMSS released items, the Filipino students got overall percent correct of less than 15% in all the five cognitive domains. Among the five domains, the Filipino participants had the lowest overall % correct in investigating and problem-solving and in communicating and reasoning. These skills are embedded in critical thinking skills because critical thinking entails effective communication and problem solving abilities

(Paul & Elder, 2008). Critical thinking and problem-solving go hand in hand. For students to learn mathematics through problem-solving, they must also learn how to think critically.

The following are some sample items:

Example 1: Cognitive Domain (Investigating and Solving Problem)

"A book publisher sent 140 copies of a certain book to a bookstore. He packed the books in two types of boxes. One type of box held eight copies of the book, and the other type of box held 12 copies of the book. The boxes were all full, and there were equal numbers of both types of boxes."

a) How many boxes holding 12 books were sent to the bookstore?

Correct response:___7___

a. Filipino Learners Overall % correct: 2% Lowest % correct: 1%

b) What fraction of the books sent to the bookstore were packed in the smaller boxes?

Correct response:__2/5 or another fraction or percent equivalent to 2/5 (e.g. 8/20, 10/25, etc.)

b. Filipino Learners Overall % correct: 1% Countries Lowest % correct: 0%

Example 2: Cognitive Domain (Communicating and Reasoning)

"Chris plans to order 24 issues of a magazine. He reads the following advertisements for two magazines. Ceds are the units of currency in Chris' country".

Teen Life Magazine 24 issues First four issues FREE	Teen News Magazine 24 issues First six issues FREE

Which magazine is the least expensive for 24 issues? How much less expensive? Show your work?

Correct response: "Teen Life. (60 ceds for Teen Life and 63 ceds for Teen News). Savings of 3 ceds."

Filipino Learners Overall % correct: 3% Countries Lowest % correct:1%

The 2003 Grade 8 Mathematics (IEA, 2005)

The TIMSS 2003 Grade 8 Mathematics assessment items included content domains of algebra, data, geometry, measurement, and number. Likewise, it contained cognitive domains of knowing facts and procedures, using concepts, solving routine problem, and reasoning. Table 3 shows the items in the 2003 Grade 8 Mathematics where Filipino learners performed very low.

Table 3

*Items in the 2003 Grade 8 Mathematics where Filipino Learners Performed Very Low**

Content Domain	Topic	Cognitive Domain	Overall % Correct*	Lowest % Correct
Algebra	Algebraic Expressions	Reasoning	5%	0%
Algebra	Patterns	Reasoning	14%	4%
Algebra	Patterns	Solving Routine Problem	11%	0%
Algebra	Patterns	Reasoning	4%	0%
Data	Data Interpretation	Reasoning	11%	1%
Data	Data Interpretation	Solving Routine Problem	10%	4%
Data	Data Interpretation	Solving Routine Problem	1%	0%
Data	Data Interpretation	Solving Routine Problem	0%	0%
Geometry	Congruence and Similarity	Knowing facts and procedures	11%	7%
Geometry	Lines and Angles	Reasoning	11%	4%
Geometry	Symmetry and Translation	Reasoning	1%	0%
Geometry	Two- and Three-Dimensional Shapes	Solving Routine Problem	15%	15%
Geometry	Two- and Three-Dimensional Shapes	Solving Routine Problem	6%	5%
Measurement	Tools, Techniques and Formulas	Solving Routine Problem	14%	13%
Measurement	Tools, Techniques and Formulas	Solving Routine Problem	8%	4%
Measurement	Tools, Techniques and Formulas	Solving Routine Problem	10%	2%
Measurement	Tools, Techniques and Formulas	Solving Routine Problem	2%	1%
Measurement	Tools, Techniques and Formulas	Solving Routine Problem	14%	2%
Measurement	Tools, Techniques and Formulas	Reasoning	2%	1%
Number	Fractions and Decimals	Knowing facts and procedures	13%	6%
Number	Fractions and Decimals	Using Concepts	25%	21%
Number	Ratio, Proportions, and Percent	Reasoning	2%	0%
Number	Whole Number	Solving Routine Problem	3%	0%

Note: * The Philippines belongs to the lowest 3 or the overall Percent Correct on the item is 15% or lower

In the 2003 TIMSS released items, the Filipino learners also got overall percent correct of less than 15% in all the four (4) cognitive domains. Among the four (4) domains, the Filipino participants had the lowest overall % correct

in solving routine problems and reasoning. The following are some sample items.

Example 3: Cognitive Domain (Reasoning)

" If a + 2b = 5 and c = 3, what is the value of a + 2(b + c)?"

Correct response: 11

Filipino Learners Overall % correct: 5% Countries Lowest % correct: 0%

Example 4: Cognitive Domain (Solving Routine Problem, Reasoning)

In a car rally two checkpoints are 160 km apart. Drivers must travel from one checkpoint to the other in exactly 2.5 hours to earn maximum points.

A. What must the average speed be to travel the 160 km in this time?
Correct response: 64kph

a. Filipino Learners Overall % correct: 14% Countries Lowest % correct: 2%

B. A driver took 1 hour to travel through a 40 km hilly section at the beginning of the course.
What must the average speed, in kilometers per hour, be for the remaining 120 km if the total time between checkpoints is to be 2.5 hours?

Correct response: 80kph

b. Filipino Learners Overall % correct: 2% Countries Lowest % correct: 1%

When compared to the Mathematics performance of the Grade 4 Filipino learners, these results showed similar pattern.

The 2003 Grade 4 Mathematics (IEA, 2005)

The 2003 Grade 4 Mathematics assessment included content domains of patterns and relationship, data, geometry, measurement, and numbers. Likewise, it also included cognitive domains of knowing facts and procedures, using concepts, solving routine problems and reasoning. Table 4 shows the items in the 2003 Grade 4 Mathematics where Filipino learners performed very low.

Table 4

*Items in the 2003 Grade 4 Mathematics where Filipino Learners Performed Very Low**

Content Domain	Topic	Cognitive Domain	Overall % Correct*	Lowest % Correct
Patterns and Relationship	Equations and Formulas	Using Concepts	4%	2%
Geometry	Two- and Three-Dimensional Shapes	Knowing facts and procedures	10%	6%
Geometry	Two- and Three-Dimensional Shapes	Knowing facts and procedures	7%	5%
Number	Fractions and Decimals	Solving Routine Problem	14%	1%
Geometry	Two- and Three-Dimensional Shapes	Solving Routine Problem	11%	11%
Measurement	Tools, Techniques and Formulas	Reasoning	5%	5%
Measurement	Tools, Techniques and Formulas	Solving Routine Problem	15%	11%
Number	Fractions and Decimals	Solving Routine Problem	1%	0%
Number	Fractions and Decimals	Solving Routine Problem	14%	7%
Number	Whole Numbers	Solving Routine Problem	11%	11%
Number	Whole Numbers	Solving Routine Problem	9%	9%
Number	Whole Numbers	Solving Routine Problem	3%	3%
Number	Whole Numbers	Using Concepts	13%	5%
Number	Whole Numbers	Using Concepts	13%	4%
Number	Whole Numbers	Using Concepts	12%	0%

Note: * The Philippines belongs to the lowest 3 or the overall Percent Correct on the item is 15% or lower

These results reveal that in 2003, the Grade 4 Filipino learners who participated in the TIMSS assessment got overall percent correct of less than 15% in all the four (4) cognitive domains. Among the four (4) domains, the Filipino learners had the lowest overall correct in solving routine problem and using concepts.

The following are the sample problems:

Example 5: Cognitive Domain (Using concepts)

37 x ___ = 703

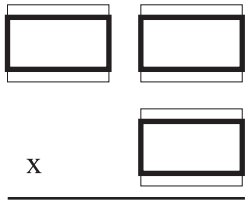
What is the value of 37 x ___ + 6?

Correct response: 709 or 703 + 6

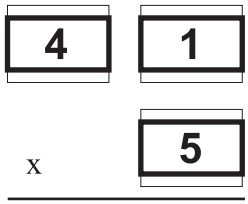
Filipino Learners Overall % correct: 4% Countries Lowest % correct: 2%

Example 6: Cognitive Domain (Solving Routine Problem, Reasoning)

Use the numbers 1 , 4 , and 5 . Write the numbers in the boxes below to make the largest answer when you multiply.



Correct Response:



Filipino Learners Overall % correct: 3% Countries Lowest % correct: 3%

Lesson Exemplars

The lesson exemplars that were developed followed the format in the K-12 framework. There were 6 Mathematics lesson exemplars prepared: one (1) in Numbers and Number Sense, two (2) in Algebra, 2 in Statistics, and 1 in Geometry. The numbers were uneven in as much as only those concepts that were considered to be critical and difficult to teach were prioritized.

When choosing an instructional model, the students sought teacher's strategies that helped students gained complete understanding of new concepts. They aimed to engage students, motivated them to learn, and guided them toward skill development. One of the ways to do that is by incorporating inquiry-based approaches like the 5E Model, which is grounded in active learning (Balci, S., Cakiroglu , J., & Tekkaya, C., 2006).

The plans made use of the 5E model of Science instruction which is a student-led inquiry-based learning method. In this format, the teacher is a facilitator who guides the students through questions, investigations, experiences, and research. It is expected that at the end of every lesson, students will be able to arrive at a deep understanding of fundamental scientific concepts.

The 5E model of Science Instruction is composed of Stage1: Engage phase; Stage 2: Exploration phase; Stage 3: Explanation phase; Stage 4: Extension phase; and Stage 5: Evaluation phase.

In the **Engage phase**, the teacher connects the students' present concept

on a particular topic with previous knowledge, understanding, and experience. Students also ask questions and the teacher notes any misconceptions without correcting them. The students start and try to develop their idea for specific concepts. It is anticipated that at the end of this phase students' interest is achieved, and students are now ready to move on and explore further about the topic.

During the **Exploration phase**, students actively explore the new concepts through concrete learning experiences. They might be asked to go through the scientific method and communicate with their peers to make observations. This phase allows students to learn in a hands-on way.

The **Explain phase** is a teacher-led phase that helps students synthesize new knowledge and ask questions if they need further clarification. For the Explain phase to be effective, teachers should ask students to share what they learned during the Explore phase before introducing technical information in a more direct manner, according to "The 5E Instructional Model: A Learning Cycle Approach for Inquiry-Based Science Teaching." This is also when teachers utilize video, computer software, or other aides to boost understanding.

The **Elaboration phase** of the 5E Model focuses on giving students space to apply what they have learned. This helps them to develop a deeper understanding. Teachers may ask students to create presentations or conduct additional investigations to reinforce new skills. This phase allows students to cement their knowledge before evaluation.

The 5E Model allows for both formal and informal assessment. During the **Evaluation phase**, teachers can observe their students and see whether they have a complete grasp of the core concepts. It is also helpful to note whether students approach problems in a different way based on what they learned. Other helpful elements of the Evaluate phase include self-assessment, peer-assessment, writing assignments, and exams.

These lesson exemplars were content validated by experts and were revised based on the comments of the observers during the try-out. Some of the comments during the try-out include: (1) Make sure that the activities are matched with the learning objectives and the assessment; (2) Create more groups (may be 6-10) to allow maximum participation of each learner; (3) Create more hands on activities (instead of teachers asking scaffolding questions) and let the students discuss their answers or solutions; (4) Think of how to make the lesson more engaging. Students become more active learners when they are engaged with the activities; (5) Make provision on how learners can present their solutions or answers to the whole class; and (6) Review the time allotment. The lesson maybe extended to the next session as required by the activities.

Assessment Exemplars

One hundred twenty (120) Mathematics assessment exemplars were developed that address the cognitive levels as revealed in the TIMSS. These 120 items were distributed as follows: 35 in Numbers and Number Sense, 30 in Algebra, 25 in Statistics and 30 in Geometry. These assessment exemplars were face and content validated by experts and administered to Grade 8 learners in the WVSU Integrated Laboratory School.

Reliability of the Mathematics Assessment Exemplars and the Its Subtests in Different Content Areas

The Mathematics assessment exemplars were administered to the Grade 8 learners of the Integrated Laboratory School last November 15, 2018. The Cronbach alpha coefficients of the overall mathematics test and its subtests in different content areas are shown in Table 5. Results show that the overall Mathematics assessment exemplars and the subtests in Numbers and Number Sense and Geometry are considered as reliable. The reliability coefficients for Algebra and Statistics appear to be low, but this does not mean that the tests are not reliable. Further analyses of the assessment has shown that the Grade 8 learners have not answered most of the items correctly; that is, they have not learned the concepts nor have acquired the skills or competencies covered by the test items.

Table 5

Reliability Coefficients of the Overall Mathematics Assessment Exemplars and Its Subtests in Different Content Areas

Mathematics Content Areas	Number of Items	Cronbach Alpha Coefficient
Numbers and Number Sense	35	.738
Algebra	25	.350
Geometry	30	.885
Statistics	30	.351
Overall	120	.721

Table 5 reveals the overall and specific Cronbach alpha coefficients of mathematics assessment. The table shows that the reliability coefficient of mathematics assessment exemplars overall is .721 which is acceptable. In addition, among the Mathematics content areas, Algebra and Statistics have lower Cronbach alpha coefficients. This implies that items in these content areas are not familiar to the learners, which may be attributed to the kind of exposure of the learners in the classroom. Generally, the Mathematics

assessment could be allowed to proceed. Moreover, some of the items could not be deleted since these items could give good information as to which competencies and kinds of questions are parallel to TIMMS assessment and relevant in the classroom

Performance of the Grade 8 Learners in the Different Items in the Mathematics Assessment Exemplars

This section shows the performance of the Grade 8 learners in the Mathematics assessment exemplars in four (4) content areas: Numbers and Number Sense, Algebra, Statistics and Geometry. The number of students who got correct answers per item is shown. This is to identify the competencies that students have developed or will still develop.

Table 6

Number of Grade 8 Learners Who Answered Correctly in the Different Items in Numbers and Number Sense Exemplars (n=47)

Item Number	Male	Female	Total	% Correct
1	20	27	47	100
2	18	27	45	95.7
3	16	21	37	78.7
4	14	15	29	61.7
5	15	11	26	55.3
6	0	3	3	6.4
7	19	23	42	89.4
8	16	7	23	48.9
9	5	21	26	55.3
10	17	15	32	68.1
11	12	9	21	44.7
12	9	2	11	23.4
13	10	9	19	40.4
14	13	11	24	51.1
15	13	11	24	51.1
16	12	5	17	36.2
17	12	10	22	46.8
18	10	7	17	36.2
19	18	19	37	78.7
20	12	20	32	68.1
21	13	8	21	44.7
22	10	6	16	34.0
23	18	16	34	72.3
24	5	7	12	25.5
25	0	0	0	0
26	6	6	12	25.5
27	4	3	7	14.9
28	6	0	6	12.8
29	10	6	16	34.0
30	3	2	5	10.6
31	6	4	10	21.3
32	1	6	7	14.9
33	6	10	16	34.0
34	11	13	24	51.1
35	0	0	0	0

Table 6 shows the number of Grade 8 learners who answered correctly in the different items in Numbers and Number sense assessment exemplars (n=47). The learners had 20 % and below correct response in 7 out of 35 items. These items include 6, 25, 27, 28, 30, 32, and 35. These seven (7) items belong to the Cognitive Domains of knowing facts and procedure, reasoning, using concepts and solving routine problems. This result somehow validated the TIMSS 1999 and 2003 results (IAE, 2005 and IEA, 2001).

Performance of the Grade 8 Learners in the Different Items in Geometry Assessment Exemplars

Table 7

Number of Grade 8 Learners Who Answered Correctly in the Different Items in Geometry Exemplars (n=47)

Item Number	Male	Female	Total	% Correct
1	8	13	21	44.7
2	0	0	0	0
3	6	8	14	29.8
4	1	0	1	2.1
5	4	5	9	19.1
6	0	2	2	4.3
7	3	0	3	6.4
8	1	5	6	12.8
9	1	10	11	23.4
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	1	0	1	2.1
14	0	1	1	2.1
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	12	5	17	36.2
19	0	1	1	2.1
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	1	1	2.1
25	0	1	1	2.1
26	0	0	0	0
27	0	0	0	0
28	1	0	1	2.1
29	0	3	3	6.4
30	0	0	0	0

Table 7 shows the number of Grade 8 learners who answered correctly in the different Items in Geometry assessment exemplars (n=47). The learners had 20 % and below correct response in 26 out of 30 items. These items include 2, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30. These twenty four (24) items belong to the Cognitive Domains of knowing facts and procedure, reasoning, and solving routine problems. This somehow validated the TIMSS 1999 and 2003 results (IAE, 2005 and IEA, 2001).

Performance of the Grade 8 Learners in the Different Items in Algebra Assessment Exemplars

Table 8

Number of Grade 8 Learners Who Answered Correctly in the Different Items in Algebra Exemplars (n=47)

Item Number	Male	Female	Total	% Correct
1	14	7	21	44.7
2	19	25	44	93.6
3	0	6	6	12.8
4	14	15	29	61.7
5	15	12	27	57.4
6	14	8	22	46.8
7	11	12	23	48.9
8	11	10	21	45.7
9	5	2	7	14.9
10	9	21	30	63.8
11	4	3	7	14.9
12	3	4	7	14.9
13	6	11	17	36.2
14	6	11	17	36.2
15	8	13	21	44.7
16	17	19	36	78.3
17	15	19	34	72.3
18	15	17	32	68.1
19	10	8	18	38.3
20	7	14	21	44.7
21	1	1	2	4.3
22	2	3	5	10.6
23	3	11	14	29.8
24	15	11	26	55.3
25	6	8	14	29.8

Table 8 shows the number of Grade 8 learners who answered correctly in the different Items in Algebra assessment exemplars (n=47). The learners had 20 % and below correct response in 7 out of 25 items. These items include 3, 9, 11, 12, 13, 21, and 22. These seven (7) items shows that these items belong to the Cognitive Domains of reasoning and solving routine problems. This shows that the results of TIMSS 1999 and 2003 were validated (IAE, 2005 and IEA, 2001).

Performance of the Grade 8 Learners in the Different Items in Statistics Assessment Exemplars

Table 9

Number of Grade 8 Learners Who Answered Correctly in the Different Items in Statistics Exemplars (n=47)

Item Number	Male	Female	Total	% Correct
1	13	15	28	59.6
2	3	5	8	17.0
3	1	2	3	6.4
4	6	4	10	21.3
5	3	6	9	19.1
6	7	3	10	21.3
7	1	3	4	8.5
8	8	8	16	34.0
9	4	5	9	19.1
10	1	2	3	6.4
11	0	3	3	6.4
12	0	2	2	4.3
13	6	8	14	29.8
14	5	11	16	34.0
15	6	5	11	23.4
16	3	3	6	12.8
17	12	10	22	46.8
18	10	8	18	38.3
19	2	5	7	14.9
20	3	3	6	12.8
21	10	5	15	31.0
22	3	4	7	14.9
23	3	4	7	14.9
24	4	14	18	38.3
25	7	13	20	42.6
26	1	5	6	12.8
27	4	4	8	17.0
28	1	7	8	17.0
29	4	13	17	36.2
30	4	11	15	31.9

Table 9 shows the number of Grade 8 learners who answered correctly in the different Items in Statistics assessment exemplars (n=47). The learners had 20 % and below correct response in 16 out of 30 items. These items include 2, 3, 5, 7, 9, 10, 11, 12, 16, 19, 20, 22, 23, 26, 27, and 28. These sixteen (16) items belong to the Cognitive Domains of reasoning and solving routine problems. This somehow validated the TIMSS 1999 and 2003 results (IAE, 2005 and IEA, 2001).

Conclusions and Recommendations

In all the three assessments participated in by Filipino learners, one common trend can be seen: Filipino learners are poor in problem solving, reasoning, communicating and using concepts. Overall, analyses of the items where Filipino learners performed least may help the teacher to design instruction and assessments according to the needs of the class.

A look into the mathematics in the current K to 12 curriculum, critical thinking skills and problem-solving are the core of the mathematics framework. The specific skills and processes to be developed include "knowing and understanding; estimating, computing and solving; visualizing and modeling; representing and communicating; conjecturing, reasoning, proving and decision making; and applying and connecting", (Department of Education, 2013). The teaching of Mathematics therefore, needs to be focused on understanding, critical thinking, problem-solving, reasoning, communicating, making connections, representations, and decisions in real life.

These results have many implications for Mathematics teachers regarding the learning experiences that are provided to the students. The kind of learning activities that teachers give to students should provide them opportunities to develop as many of the above skills and processes. This task calls for creativity and resourcefulness on the part of the teachers. Are our mathematics teachers ready for this?

These results can inform the pedagogy and assessments to develop inquiry skills among students. There are implications for teachers when they design instruction and assessments according to the needs of the class. The items in the TIMSS that were released that coincide with the concepts taught in class may allow the teacher to get feedback on the students' understanding of assessed concepts. Further, results have implications as to how mathematical concepts may be taught and how assessment items may be constructed to identify particular difficulties or alternative conceptions by individual students.

As the Department of Education implements the K to 12 curriculum, it is imperative that mathematics teachers should possess the pedagogical knowledge on how critical thinking and problem-solving skills are developed among students. As stipulated in the K to 12 Mathematics Conceptual framework, "critical thinking and problem solving are the twin goals of Mathematics in the basic educational level, K to 10" (Department of Education, 2013). Further, the framework stipulates that "these two goals are to be achieved with an organized and rigorous curriculum content, a well-defined set of high-level skills and processes, desirable values and attitudes, and appropriate tools, taking into account the different context of Filipino

learners" (Department of Education, 2013).

As stipulated in R.A. 10533 known as the Enhanced Basic Education Act of 2013, "the Basic Education shall develop the enhanced basic education curriculum that is learner-centered, inclusive and developmentally appropriate, culture-sensitive, contextualized and global, utilizing pedagogical approaches that are constructivist, inquiry-based, reflective, collaborative and integrative" (R.A. 105533, 2013). This expectation is indeed a tall order for Mathematics teachers. What the Mathematics teachers can do is to arm themselves with Mathematics content knowledge and pedagogical content knowledge and skills, be more creative in their teaching strategies, and use appropriate technology or tools in teaching Mathematics to develop inquiry skills among students.

The developed lesson exemplars can be used by teachers as a guide in teaching since the use of 5E model enabled the students to have significantly better acquisition of scientific conceptions than traditional instruction (Balci, S., Cakiroglu , J., & Tekkaya, C.,2006) and increased learning and retention of science lessons (Fazelian, P., Naveh Ebrahim, A., & Soraghi, S., 2010). The 5E learning cycle model positively affects student achievement and the permanence of knowledge (Tuna, A., Kacar, A., 2013).

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