ELEMENTARY SCHOOL TEACHER'S PROBLEMS IN THE PROCESS OF PEDAGOGICAL REASONING IN PROPORTION FROM THE PERSPECTIVE OF CURRICULUM MAKER

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Abstract

The purpose of this study is to describe how mathematic teacher's problems occur in the process of pedagogical reasoning from the perspective of a curriculum maker. In order to grasp the structure of the problems, we show the conceptual framework of the curriculum, which has five levels: the intended curriculum, the teacher-intended curriculum, the enacted curriculum, and the teacher-recognized attained curriculum, as well as the attained curriculum. The sample for this study was one single female teacher who was teaching in the sixth grade in elementary school in the Philippines. The observed lesson was finding missing term in proportion. The methods were lesson observation, a researcher-designed short test for students, questionnaire and interview with the teacher. The study determined the teacher's problems leading to curriculum gaps among five levels of the curriculum. It was revealed that the learning contents in the attained curriculum was less than the teaching contents in the intended curriculum, because of a lack of stressing conceptual understanding in the teacher-intended curriculum. The most important finding is that she did not recognize those curriculum gaps, because learning contents in the teacher-recognized attained curriculum was the same as teaching contents in the teacher-intended curriculum from her view.

Key words: curriculum maker, curriculum gaps, pedagogical reasoning

INTRODUCTION

Over the past few decades, a considerable number of studies have been conducted on teachers and teaching. Considering the classroom situation, a teacher's role is not to give knowledge written in the curriculum, but to transform the intended curriculum such as a syllabus, and make it more comprehensible based on the previous lessons. In this sense, we would like to introduce the term "curriculum maker" (Clandinin & Connelly, 1992) as the active role of teachers against with "conduit metaphor". Cai & Howson (2012) stated the word, a curriculum maker as follows:

"to engage in the process of developing a coherent sequence of learning situations, together with appropriate materials, the implementation of which has the potential to bring about intended change in learners' knowledge." (p.952)

From the standpoint of a curriculum maker, this study focuses on teachers' activity in the process of pedagogical reasoning: i.e., comprehension, transformation, instruction, evaluation, and reflection (Shulman, 1987). Teachers are situated in an important position connecting the intended curriculum and the attained

curriculum, and working on both curricula. We would like to describe how teachers interpret the intended curriculum and conduct lessons with students, and further how they recognize students' knowledge and skills.

First of all, we present the framework, five levels of curriculum based on three levels of curriculum (Travers & Westbury, 1989). Second, using the case of one single teacher in the Philippines, we would like to make clear the problems related to teachers that are lead to shrink the implemented curriculum, which are the knowledge and skills students obtain.

THEORETICAL FRAMEWORK

The notion of curriculum is very broad (e.g. Jackson, 1992; Wong et al., 2014), and there are many terms used in different contexts. However, generally there are two different types of curricula: official curricula and operational curricula. The operational curriculum includes the teacher-intended curriculum, the curriculum that is actually enacted with students, and student outcome (Remillard & Heck, 2014). We introduce the conceptual framework of curriculum based on the IEA Study as official curricula and Remillard & Heck's perspective as operational curricula. We named it "Five levels of curriculum", consisting of the intended curriculum, the teacher-intended curriculum, the enacted curriculum, the teacher-recognized attained curriculum, and the attained curriculum (Arai, 2018).

The reason why we need five levels of curriculum is to focus on the teacher's position as we previously mentioned. Let us explain more. We need to consider how teachers work on the intended curriculum as well as the attained curriculum as curriculum makers, therefore we divided the implemented curriculum into three levels. The teacher-intended curriculum is the product after transforming the intended curriculum. The teacher-recognized attained curriculum is the product after recognizing the attained curriculum. Both of them belong to the teachers. As such three levels are set, each level corresponds to pedagogical reasoning. Table 1 shows the teacher-intended curriculum corresponds to the comprehension and the transformation, the enacted curriculum corresponds to the instruction, and the teacher-recognized attained curriculum corresponds to the evaluation and the reflection. Above all, the teacher-recognized attained curriculum is a very important level to analyze the data in our study, because the aspect of student outcome from the teacher's side relates to evaluating not only students, but also the teacher him/herself. The evaluating of him/herself by his/her own lead to the reflection.

Table 1. Conceptual framework of curriculum (Arai, 2018)

Curriculum By IEA	Curriculum By Arai (2018)	Contents	Pedagogical reasoning
Intended curriculum	Intended curriculum	In course of study Goal/Objective, teaching contents, way of teaching	
Implemented curriculum	Teacher- intended curriculum	In lesson plan Goal/Objective, teaching contents, way of teaching	Comprehension Transformation
	Enacted curriculum	In actual lesson Goal/Objective, teaching contents, way of teaching	Instruction
	Teacher- recognized attained curriculum	In assessment test learning contents (teacher recognized students obtained knowledge & skills)	Evaluation Reflection
Attained curriculum	Attained curriculum	learning contents (actually students obtained knowledge & skills)	

METHOD

Outline of the research

The research was conducted in November, 2016. The research target is a female teacher teaching sixth graders in Metro Manila in the Philippines[1]. She has ten years of experience to teach mathematics but this year was first time to teach mathematics to sixth graders. The lesson we observed was finding missing term in proportion. Before and after the lesson, we gave her questionnaire and interview, and also the students answered the short test an observer (researcher) made at the end of the lesson.

Let us move on to the procedure of our analysis using Table 1. First of all, to find gaps among five levels of curriculum, we compare between teachers' guide and lesson plan, lesson plan and actual lesson. Second, particularly the gaps between the teacher-recognized attained curriculum and the attained curriculum are described by analysis of questionnaire and interview after the lesson and results of the short test the observer made. Additionally, we are not concerned with right and wrong of the intended curriculum.

The results came out of the comparison of the objectives, teaching/learning contents, and way of teaching in each curriculum, it is showed that some gaps existed between the intended curriculum and the teacher-intended curriculum, and between the teacher-intended curriculum and the enacted curriculum. We take the gap between the intended curriculum and the teacher-intended curriculum for example. Comparing the way of teaching in teachers' guide and the lesson plan, it is described that discussion part changes to a simple question and answer in the process of transformation. Finally, we show the several gaps using Figure 1.

For the sake of the validity of this study, we were given critical advice regarding our interpretation of the data, video recording and interview by two educators in universities and one experienced teacher in the Philippines.

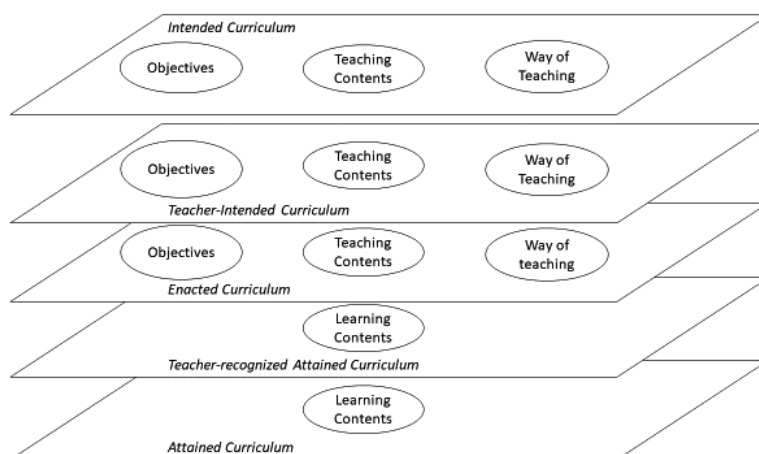1 Arai (2019) analysed the same data from the perspective of teacher's craft knowledge.

Figure 1. Research framework

RESULTS AND DISCUSSION

Comparison among intended curriculum, teacher-intended curriculum, and enacted curriculum

In the Philippines K to 12 mathematics curriculum (Department of Education, Republic of the Philippines: DepEd, 2016) has been implemented gradually since 2012. The teacher made lesson plan and conducted the lesson following teachers' guide based on K to 12. Unfortunately grade 6 teachers' guide and textbook followed the previous curriculum, Basic Education Curriculum (DepEd, 2010). The observed lesson is finding missing term in proportion. It is in the unit "Forms ratio and proportion for group of objects/ numbers" written in the Basic Education Curriculum. K to 12 describes more details that it is situated after defining and illustrating the meaning of ratio and proportion using concrete or pictorial models, setting up proportions for groups of objects or numbers and for giving situation. In the teachers' guide (DepEd, 2010), the objectives are to find missing term in proportion, write proportion correctly, and help parents at home.

Comparing the objectives between the intended curriculum and the teacher-intended curriculum, they are the same in both. And also the given problem, "During weekends, Zeny helps her mother sell buko juice. For every buko, Zeny adds 4 liters of water. How many liters of water does she need for 3 bukos so that the taste will be the same?" is the same.

However, comparing the way of teaching among teachers' guide, lesson plan and actual lesson, there are some differences (Figure 2). In teachers' guide, after setting up the proportion 1:4=3:12 or 1/4=3/12 using illustrations and introducing the terms means and extremes, a teacher ask "Discuss how to find the missing "extreme" or "means" using the given problem situation" ((A) in Figure 2). On the other hand, in the lesson plan she explains the rule in proportion like "4 and 3 are means, 1 and 12 are extremes in proportion. The product of means must be equal to the product of extremes" then says "let's apply the rule in proportion" ((B) in Figure 2). Considering these lesson procedure it is possible to say that teacher's intention was explanation of solution first then request of volunteer in the case of fraction form. In the actual lesson she explained "In proportion, the product of the means must be equal the product of extremes. So that it will become proportion". She was pointing to 1:4=3:12 written on the board and asked "What is 3×4?" The students answered "12". She asked "12×1?" The students answered "12". She asked "Is it equal?" The

Teachers' Guide	Lesson plan		lesson
	Teacher's activity	Pupils	
Introduce the terms "extremes" and "means". Discuss how to find the missing "extreme" and "means" using the given problem situation. (**A**) Buko→ Litres of water→ $\frac{1}{4}=\frac{3}{N}$ → Buko or → Litres of water 1:4=3:N Solution→1×N=4×3 1N=12 N=12÷1 or 1:4=3:N 1×N=4×3 1N=12 N=12÷1 N=12	We have two parts of proportion. Let's use the proportion in our problem. 1:4=3:12 or 1/4=3/12 4 and 3 are the means, 1 and 12 are the extremes. In proportion the products of the means must be equal to the product of extremes. Without the drawing, how are you going to illustrate or write the equation? Now let's apply the rule in proportion. That the product of means is equal to the product of extremes. (**B**) 1:4=3:N 1×N=4×3 1N=12 N=12 I need a volunteer to do this fraction form. Very good!	1:4=3:N 1/4=3/N 1×N=4×3 1N=12 N=12	T: In proportion, the product of the means must be equal the product of extremes. So that it will become proportion. What is 3×4? P: 12 T: 12×1? P: 12 T: Is it equal? P: Yes T: I need my volunteer to write an equation if one of the term is missing. P:1:4=3:N (writing on the blackboard) T: The first term is number of buko···. (**C**)

Figure 2. Comparison among teachers' guide, lesson plan and actual lesson

students said "Yes". After that she asked pupils to write the equation, then explained how to solve the problem 1:4=3:N without discussion ((C) in Figure 2). Judging from these interaction it is clear that she asked simple questions and explained how to solve following her lesson plan. Let us look at her recognition of the lesson in the questionnaire. There are six items; (1) degree of satisfaction and the reason, (2) about important points, (3) differences between the lesson plan and the lesson, (4) differences between the actual lesson and image of ideal lesson, (5) students' active situations, and (6) sufficient understanding contents and insufficient understanding contents. She described that the plan were executed as indicated in her lesson plan in item (3). Regarding discussion, she mentioned the most important part of the lesson was discussion in the interview before the lesson, and she answered "yes" to the question, "Did you teach important points properly which you emphasized before the lesson?" in the questionnaire, and also she said "yes" to our question "Did the discussion go well? " in the interview. Finally she was satisfied with the discussion.

The Filipino teacher educator's interpretation of this comparison (Figure 2) is that she might think it is discussion, because in the Filipino context, "discussion" is not a group discussion but the interaction between a teacher and students, therefore she might have satisfied with the discussion.

Comparing teaching contents between the intended curriculum and the teacher-intended curriculum, "Is the first ratio equal to the second ratio? Why?" written in teachers' guide, while in her lesson plan "The first and second ratio are equal because the first ratio is the lowest term of the second ratio" written as expected pupils' answer. Considering it, the teacher might not have recognized that introduction of proportion was an important point. If she was aware of its importance, she would have used not only the lowest term but also illustration to let students understand conception of proportion.

Comparison between teacher-recognized attained curriculum and attained curriculum

The teacher gave the evaluation test at the end of the lesson (Figure 3), while the observer gave the short test for 24 students selected at random after the lesson (Figure 4). The intention of the short test is as follows; Q1: Find the correct ratio seeing concrete objects, Q2, 3: Understand the conception of proportion using concrete objects, Q4: Find the missing term in proportion. The percentage of correct answer is Q1 (100%), Q2 (71%), Q3 (25%), Q4 (96%). Q3 is more difficult to solve than Q2 because it is not easy to find the relation 6 circles in Q3 to 4 circles in Q1. Now, we will take a close look at students' answers in Q3 (Table 2).

Find the missing term:
1. 4/7=x/14
2. n/8=5/30
3. 3/y= 9/12
4. 10/5=12/t
5. n/6=20/24
6. 6:n=6:21
7. M/7=6
Write a proportion then solve for the missing term:
8. 14 girls to 5 boys; how many boys to 28 girls
9. 3 batteries to 1 flashlights; how many batteries to 7 flashlight
10. 5 mangoes for P60; how much for 15 mangoes?

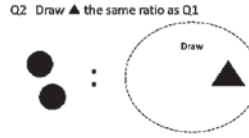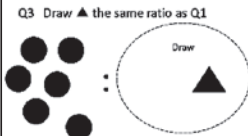Figure 3. Evaluation Test by the teacher

Figure 4. Short Test by the observer

Focusing on four students whose answer is fourteen. They could find the answer by difference. Their misconception might be that ratio of 4:12 means eight difference between four and twelve so they find the answer by 6+8=14, or six is increasing two from four so they find the answer by 12+2=14.

The interview for the teacher's concerning these results was conducted as follows;

Observer: (Showing the percentage of correct answer). What do you think these results?
Teacher: I need to give other problems related to Q2… to the equation. There are many steps… I think they have a difficulty to make lowest term.
Observer: (Showing Figure 5) In Q3 some of them made a same mistake, 14. Why do they think fourteen triangles?
Teacher: (After confirming the question 3, she think for a few minutes) They might have counted the number of triangles by error…I don't know…

The results given above indicated that she thought poverty of the skills to find the lowest term might be the reason why many students could not solve question 3, and also she could not find students who answered 14 had a misconception.

Table 2. Results in Q3

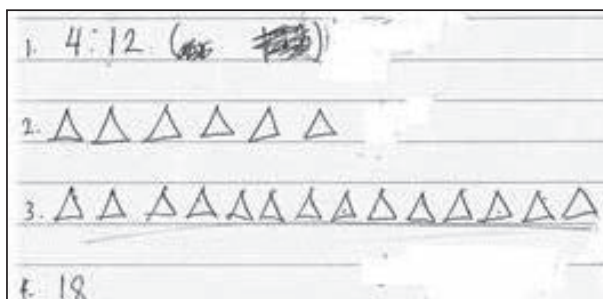| Number of triangles	2	3	6	12	13	14	16	18	24	N/A
Number of students (N=24)	1	2	2	3	1	4	1	6	2	2

Figure 5. Example of wrong answer

Having considering the results of the short test, we will return to the issue of the gaps between the teacher-recognized attained curriculum and the attained curriculum. Here is Figure 6 which shows two kinds of differences leading the gap. We would like to explain them following Figure 6. The numbers ①②③④ to below correspond to the number in Figure 6.

①(coherence)   By judging from what happened in the actual lesson the teacher-intended curriculum is that the students could find the missing term in proportion and solve their word problems. For example, 50 minute out of 70 minute was spent to fix skills which were changing one term to make them proportion, finding missing term in fraction form, and solving word problems. And also the contents of the evaluation test (Figure 3) is the one of the evidence of her expectation. While the teacher-recognized attained curriculum, her reflection of the lesson, she wrote that 100% of the students passed based on the result of the evaluation test even though she recognized one group was confused in writing the correct proportion during group activities. Thus there is a coherence between the teacher-intended curriculum and the teacher-recognized attained curriculum in the teacher's view.

②(difference)   According to our analysis of K to 12 and teachers' guide, this lesson is situated making bridge between proportion and missing term because of lesson sequence. Therefore the important point is the discussion how to find the missing term based on the conception of proportion. Thus what the intended curriculum required are not only the skills but also the conception of proportion. Comparing between the teacher-intended curriculum and the intended curriculum, teaching content in the intended curriculum includes the conception of proportion.

③(difference)   By the results of the short test, it is revealed that students could find missing term in proportion. However conceptual understanding of proportion such as a relation of two quantities was insufficient to understand. Comparing the intended curriculum, conceptual understanding of proportion was lacking in the attained curriculum.

④(coherence)   In the questionnaire, the teacher wrote that most of the students obtained the skills of finding missing term in proportion. In the short test the observer made, most of the students got the correct answer in Q4, "Find N in 2:6=6:N". Those results show the coherence between the teacher-recognized attained curriculum and the attained curriculum from a viewpoint of procedural understanding. However, as shown immediately above, there is still a difference between the observer's intended curriculum and the attained curriculum from a viewpoint of conceptual understanding.

As mentioned above, the gap exists teaching contents between the teacher-intended curriculum and the

intended curriculum (②), because a lack of the teacher's knowledge about the importance of introduction of proportion. However, an important point to emphasize is that the teacher could not recognize the gap between the teacher-intended curriculum and the intended curriculum. It is because the teacher believed the lesson worked out as shown the coherence in teacher's view(①④). In short, she is satisfied with the lesson as she wanted.
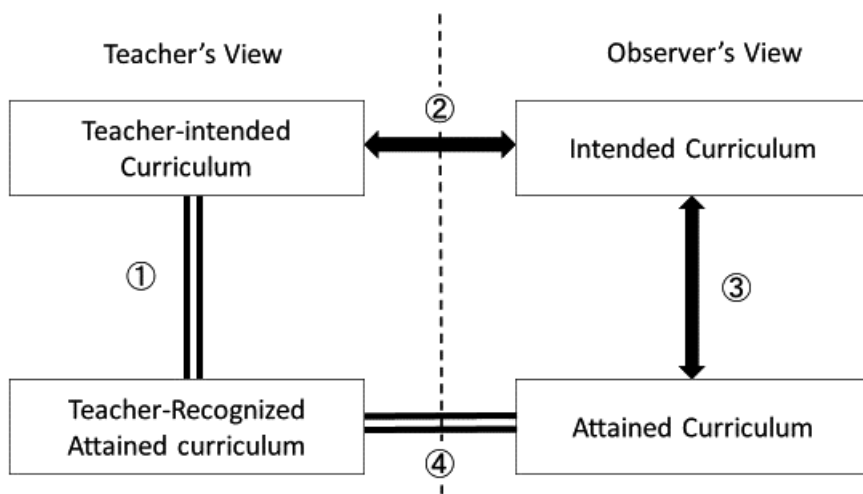

Figure 6. Curriculum from teacher's view and observer's view

CONCLUSION

From the perspective of teachers as curriculum makers, teachers should comprehend and transform the intended curriculum in their own way. If a teacher is an expert, the attained curriculum, which are knowledge and skills obtained by students, might be more than the intended curriculum. Unfortunately, in this case, Figure 7 shows that the attained curriculum was less than the intended curriculum. Figure 7 also shows that the overall gap between the intended curriculum and the attained curriculum was caused by the three gaps. The first gap was between the intended curriculum and the teacher-intended curriculum, in the transformation process. The teacher's lack of knowledge about the importance of introducing of proportion lead to shrink the teaching contents which stresses the concept of proportion in the teacher-intended curriculum, and also lead to insufficient discussion. The second gap was between the teacher-intended curriculum and the enacted curriculum, in the instruction process. Although the teaching content was the same for both, in the actual lesson, only solving algebraic equations given weight, and the teacher just explained without allowing time for question and answer (See right column in Figure 2). As a result, students could not obtain the conceptual understanding of proportion. The third gap was between the enacted curriculum and the teacher-recognized curriculum, in the evaluation process. The teacher only evaluated finding missing term using equation (See Figure 3), but did not evaluate conceptual understanding of proportion. Needless to say, it might have been caused by her instrumentalist (Ernest, 1989) mindset.

On the other hand, there is no gap between the teacher-recognized attained curriculum and the attained curriculum as shown in Figure 7. As discussed in comparison between the teacher-recognized attained

curriculum and the attained curriculum, the teacher could not recognize the actual difficulties of students. However, as we mentioned in reference to coherence ①④ in Figure 6, the teacher thought she had made a lesson plan following the intended curriculum and accomplished the objective which was to find missing term in proportion because most of the students solved the problems in the evaluation test she made. Therefore there is no gap between the teacher-recognized attained curriculum and the attained curriculum from her view. This phenomenon causes two problems. One is the teacher could not recognize the three gaps because she satisfied her transformation and instruction, the other is her satisfaction may have become an obstacle to finding the students' difficulties and changing her teaching in the process of pedagogical reasoning. If she had realized the gap between the enacted curriculum and the attained curriculum, she would have looked back on her actions in the process of reflection.

In conclusion, although there are three gaps caused by the teacher, she did not recognize them. Moreover, her satisfaction removed the opportunity to reflect on her own lesson. It suggests the further gap between the observer's intended curriculum and the attained curriculum from a perspective of conceptual understanding.

To become a teacher who continues to grow, it is necessary to learn not only the knowledge of teaching but also how to reflect on their own actions.
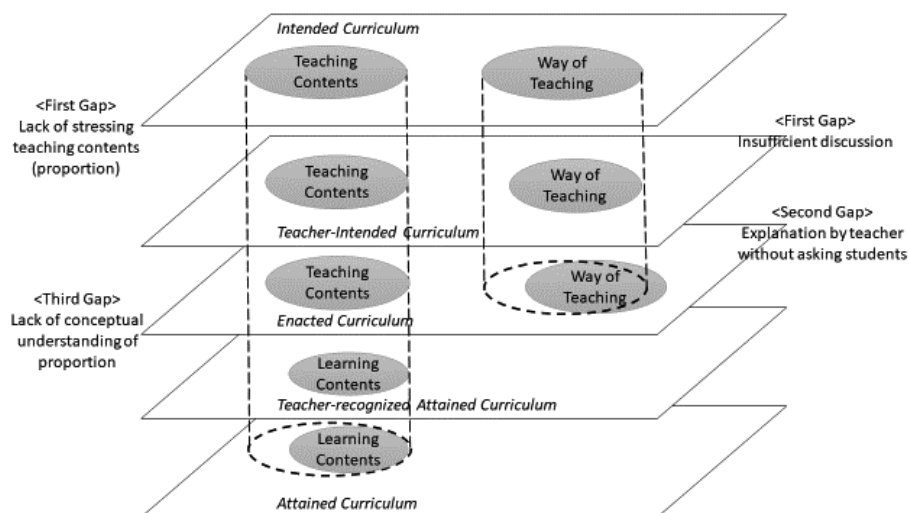

Figure 7. The gaps among five levels of curriculum

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