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The Goal of School-Based Professional Development Program for Elementary School Mathematics Teachers

CHENG, Lu Pien
National Institute of Education, Nanyang Technological University,
1 Nanyang Walk, 6376161, Singapore; Email: lupien.cheng@nie.edu.sg

KO, Ho Kyoung*
Graduate School of Education, AjouUniversity, Suwon,
Gyeonggi-do 443-749, Korea; E-mail: kohoh@ajou.ac.kr

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The goal of this study was to examine the three components of a laboratory class cycle that empowered teachers to change their teaching practices. Six teachers and their administrator in an elementary school in the southeastern United States participated in the study. All the teachers were interviewed, and their mathematics lessons were observed at the end of each cycle of laboratory classes. The study revealed how planning, observing, and critiquing mathematics lessons as a team assisted the teachers' learning and teaching. We identified opportunities for the teachers to experiment with different teaching approaches, and we found that support from the team and from the school were key factors for the laboratory class cycle to function effectively.

Keywords: professional development; school-based; laboratory class cycle; teacher learning
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INTRODUCTION

Continuing education for mathematics teachers is intended to provide teachers with new abilities and information related to the teaching of mathematics, including the use of new software and curricula. According to Dewey,

* Corresponding author

> What we want, in other words, is not so much technical skill, as a realizing sense in the teacher of what the educational development of a subject means, and, in some typical case, command of a method of control, which will then serve as a standard for self-judgment in other cases. (Dewey, 1904, p.28)

That is, besides introducing new knowledge in professional development (PD) programs for teachers, the programs should also promote reflective thinking in the teachers' special areas of expertise in order for the teachers to make sense of their situation and empower them with the ability to deal with future challenges in teaching.

Another issue facing most current knowledge-based curricula is whether they are in harmony with the teacher's present or future teaching experiences. It is important to ensure that programs in a knowledge-based curricula intended to provide new information to teachers are not too distant from the teaching experiences that the teachers share and will share with students in their actual classroom practices. Ball & Cohen (1999) emphasize that such curricula should be, above all, school-based. Specifically, this means that teachers should be encouraged to change their teaching practices by developing practical on-site knowledge based on their own experiences.

> Teachers would need opportunities to reconsider their current practices and to examine others, as well as to learn more about the subjects and students they teach (p.3) … All of these things have reinforced the conservatism of practice, with its didactic approaches to teaching and facts-and-skills conceptions of knowledge. Teachers hone their skills within that frame of reference and have few opportunities for substantial professional discourse (p. 5).

What teachers learn from teacher education programs will affect how they teach (Elmore, Peterson & McCarthey, 1996). Teachers will have difficulty in applying what they learn in PD programs into their classrooms if the programs do not take into account their teaching practices. One of the goals of teacher education is that teachers can apply the knowledge they obtain from such education to their teaching practices. Therefore, it is evident that a corresponding professional development programs should be worked out (Ball & Cohen, 1999).

This study examines the laboratory class cycle and suggests how it might provide the structure for a small community - a team of six teachers - to react to change by learning and growing through examining their teaching practices.

RELATED LITERATURE

The goals of continuing education for mathematics teachers

Feiman-Nemser (2001) used the assisted performance model to think about teacher learning over time from initial teacher preparation through early years of teaching. The

framework also suggested specified tasks to be accomplished in the preservice, induction, and continuing professional development phases of a teacher's career. In particular, she identified four tasks that are central to the continuing professional development phase:

1. Extend and deepen the subject matter knowledge necessary for one's teaching,
2. Extend and refine one's repertoire in curriculum, instruction, and assessment,
3. Strengthen the skills and dispositions necessary to study and improve teaching, and
4. Expand responsibilities and deepen leadership skills(p. 1050).

As we describe the laboratory class cycle and provide evidence of the teachers' learning, we also describe the ways in which the laboratory class cycle engaged the teachers in the first three task by Feiman-Nemser Our goal is to use the teachers' responses and reactions to the laboratory class cycle to demonstrate that the laboratory class is able to provide a form of assisted performance to guide teachers learning.

Against Which Pedagogical and Philosophical Backgrounds Should the Attempts bemade to Enhance the Professionalism of Mathematics Teachers?

> We thus reach a technical definition of education: It is that reconstruction or reorganization of experience which adds to the meaning of experience, and which increases ability to direct the course of subsequent experience (Dewey, 1944, p. 76).

Translating Dewey's notion of education to teacher education, this implies that a teacher recomposes or reorganizes the significant experiences he/she has obtained in his/her classes.

Dewey (1958) said, "Education and experience cannot be directly the same as each other" (p. 25). Therefore, the mere fact of having had an experience does not enable one to apply such an experience to education. Dewey (1958) suggested that experiences can be divided into primary and secondary, or reflective, experiences according to the quality of systematic thinking applied to the experience. "The distinction is one between what is experienced as the result of minimum of incidental reflection and what is experienced in consequence of continued and regulated reflective inquiry" (Dewey, 1958, p. 4). Accordingly, teacher experiences can be divided according to the quality of thinking involved. Existing teachers had already had their own experiences in the classroom. This will be regarded as primary experiences in this study. Consequently, "it is required to make the secondary experiences or re-experiences for continuous experiences" (Archambault, 1974, p. 200). This corresponds to the principle of experience continuity that Dewey referred to. The secondary experiences can be formed, while creating new observations and experiments using the things from raw experiences as the data for reflective thinking (Dewey,

1958):

> Reflection involves not simply a sequence of ideas, but a consequence - a consecutive ordering in such a way that each determines the next as its proper outcome, while each in turn leans back on its predecessors (Dewey, 1910, p. 2–3).

After all, education is an ability to understand the results of experiences. Accordingly, teacher education can help teachers increase the meaning of their own experiences, enabling them to predict results for new experiences with students and to set directions for learning. In pursuing the intellectual growth of teachers, it is important to keep in mind that intellect is not built in a moment, nor is it static once it has been formed:

> Intelligence is not something possessed once and for all. It is in constant process of forming, and its retention requires constant alertness in observing consequences, an open-minded will to learn and courage in re-adjustment (Dewey, 1948, p.96–97).

This requires an attitude that goes beyond the simple acquisition of knowledge. It requires one to maintain a "student attitude," always ready to learn new things and to readjust one's thinking in response to those new things whenever necessary:

> … "progress" may with such consist only in perfecting and refining skills already possessed. Such persons seem to know how to teach, but they are not students of teaching. Even though they go on studying books of pedagogy, reading teachers' journals, attending teachers' institutes, etc., yet the root of the matter is not in them, unless they continue to be student of subject-matter, and student of mind-activity. Unless a teacher is such a student, he may continue to improve in the mechanics of school management, but he cannot grow as a teacher, an inspirer and director of soul-life (Dewey, 1904, p.15).

Assuming such an attitude towards intellectual growth, the promotion of reflective thinking should build upon certain basic personal characteristics and attitudes:

> To be an effective method in addressing subjects, the reflective thinking should be based on some attitudes, of which 'directness', 'open-mindedness', 'whole-heartedness' and 'responsibility' are the most important(Dewey, 1944, p. 173).

Above all, these attitudes are emphasized because reflective thinking based on such frames of mind can offer opportunities to enlarge knowledge and self-recognition (Rodgers, 2002). Roger emphasized "whole-heartedness" or the "attitude of putting heart and soul" into a task. According to Rodgers, it is difficult to develop reflective quest without ~~the~~ curiosity and enthusiasm for the subject matte. Therefore, Rodgers believed that such an attitude should be prioritized when working to improve a teacher's professionalism. He refers "directness" to a willingness to see things as they are rather than holding fast to one's own beliefs.

According to Dewey, reflective thinking is necessary to unveil factors that support (a) a state of perplexity, hesitation or doubt and (b) suggested beliefs or to abolish suggested

beliefs (Dewey, 1910); a certain "problem", described as lack in certainty resulting from dubiousness and doubtful belief. Answers can be obtained, as the factors for clarity are abruptly presented, but can be revealed by describing evidences. The gist for such quest is to consolidate or refuse a suggested belief. To find the factors to ensure or refuse your beliefs, a teacher should first set aside the beliefs that he or she has accumulated through past experiences (Rodgers, 2002). For example, suppose a student calculating $3 \times 2/5$ arrived at 6/15. An explanation for the incorrect calculation would be that the student multiplied both the denominator and numerator by 3. What should not be forgotten in teaching mathematics is that a teacher should look at a student's learning from the student's perspective, not from the teacher's (Ball & Cohen, 1999). Because a teacher has formed his or her mathematical knowledge through his or her own experiences, it will not be easy to observe clearly what is occurring during a student's learning process. It is impossible to describe what happens with each student, but the essence of teaching lies in the growth of reflective thinking (Rodgers, 2002).

When observing a student's behavior~~s~~ and responses, a teacher needs to look at the student's mathematics objectively. If the teacher insists on analyzing the student's mathematics from his or her own perspective, it will likely result in an interpretation that is utterly different from the student's. Dewey further noted that "The habit of making isolated and independent lesson plans for a few days' or weeks' instruction in a separate grade here or there not only does not answer this purpose, but is likely to be distinctly detrimental" (Dewey, 1904, p. 25). Thus, it is necessary to provide an environment that so promote reflective thinking supported by educational theories and focusing on students' mathematical thinking.

Ball & Cohen (1999) proposed "practice-based materials" focusing on the practical classroom circumstances of teaching and learning and on activities that promote thinking in teachers. They also proposed ~~a~~ "practice-based discussion" to effectively identify what teachers should know. If a professional development program for teachers prioritizes the use of teaching experiences to contribute to the growth of experiences, it follows that each teacher should start from his or her own experiences and gradually develops new knowledge and skill. In other words, the program should be able to provide opportunities for teachers to explore and develop better ideas or attitudes drawn from the teacher's knowledge derived from his or her own experiences.

In explaining Dewey's views, Rodgers describes observation and experience as the main factors that enable the development of reflective thinking, emphasizing not only general experiences but also experiences that can be connected to theory. In addition, he suggests that the concept of continuity be viewed as an experience, arising within a learning or inquiry community that emphasizes practice and efficiency.

This experimentation, which involves interaction between the self, others, and one's

> environment, in turn serves as the next experience from which learning can continue, a phenomenon that Dewey called continuity. This can all happen in solitude, but in community with others the learner will broaden his or her understanding of an experience beyond where it might go in isolation (Rodgers, 2002, p. 863).

What should be sought in the Professional Development Program for Teachers?

Dewey said that systematic practice and training are required for reflective thinking (Archambault, 1974). Reflective thinking has its origin in the scientific method and should include "a test of theory" (Rodgers, 2002, p. 863). He recommended the following precise steps: detailed description of observations and experiences, the analysis of experiences, including general explanations, and experimentation. Accordingly, professional development programs for teachers should be conducted in ways that are designed to cultivate the reflective thinking of teachers.

Smith (2001) proposed an approach to professional development that focused on understanding students' mathematical thinking based on what the teacher observed in practice. In particular, he proposed a cycle that a teacher should perform. The first step in the cycle is preparation for teaching, which involves deciding what mathematical knowledge and procedures the student should learn. The second step in the cycle is the actual teaching, performing the lesson that has been prepared. This is followed by the teachers' engagement in reflection and analysis of students' mathematical thinking to determine the students' levels of mathematical understanding.

Dewey (1944)said that improving reflective thinking requires scientific and systematic processes, and he proposed a five-stage method to achieve such a purpose: "First, having a genuine situation of experience; secondly, that a genuine problem develop within this situation as a stimulus to thought; third, that he possess the information and makes the observations needed to deal with it; fourth, that suggested solutions occur to him which he shall be responsible for developing in an orderly way; fifth, that he has opportunity and occasion to test his ideas by application, to make their meaning clear and to discover for himself their validity" (p. 163).

Rogers (2002, p.851) built the following systematic stages for reflective thinking based on Dewey's stages:

1. An experience;
2. Spontaneous interpretation of the experience;
3. Naming the problem(s) or the question(s) that arises out of the experience;
4. Generating possible explanations for the problem(s) or question(s) posed;
5. Developing the explanations into full-blown hypotheses; and
6. Testing the selected hypothesis.

When these stages are applied to a professional development program for teachers, it implies that the program should start with a problem created through the unclear and spontaneous "interpretation" of primary practice experiences:

> The process of reflection, Dewy claims, moves the learner from a disturbing state of perplexity (also referred to by him as disequilibrium) to a harmonious state of settledness equilibrium (Rodgers, 2002, p.850).

The program's success depends on how well knowledge and problems obtained from practical teaching experiences can be concretized through discussion in a community during the third and fourth stages. These stages involve extracting practical problems based on teacher's experiences. The problems are defined from the discussions between the teachers and their professional developer (hereinafter referred to as the developer) – harmonizing theory and reality. In the fifth phase, the developer draws upon pedagogical principles and theories to develop an approach and a plan for the inquiry community to address the problems identified. "The object of experimentation is the construction, by regular steps taken on the basis of a plan thought out in advance, of a typical, crucial case" (Dewey, 1910, p. 91). In this phase, the inquiry community also makes hypotheses about possible outcomes of the approach.

In the sixth phase, the inquiry community carries out the plan and verify the hypotheses to be tested. This phase offers secondary (educational) experiences for the inquiry community as they experiment, test out the approach observe others teach and make the theory-practice link. This offers the inquiry community deeper understanding of students, teaching and learning.

The seventh phase is the analysis, expansion, and application of the test results. Discussion in this phase allows a teacher to apply the results to his or her classes and plan for the appropriate instruction. Through such discussions, teachers can improve their reflective thinking, apply the results from the professional development program to their classes, and bring about changes in practical teaching conditions. Besides 'picking up' effective instructional strategies from the observing others teach, a series of such activities is pursued to increase the teachers' experience and their ability to think about their teaching. In this sense, the professional development goes beyond providing knowledge for teachers.

METHODOLOGY

The program involves the use of laboratory class cycle. In the laboratory class cycle, the inquiry community plans, observes and reflects on mathematics lessons.

Interpretative analyses and a grounded theory approach were used to generate descrip-

tions of the responses to the program by the teachers and their administrator. Pseudonyms were assigned to the school and the participants to ensure confidentiality.

Setting

The program and research were conducted in Dayspring Primary School. The school is a public school in a historic town 50 miles east of a large city. Dayspring is in a rural section of Dalton County, which includes two other communities. Dalton County has a population of almost 40,000, and Dayspring has about 3,500 residents. The Dayspring district runs its own independent school system. There are five schools in Dayspring district, with a total of 1500 students: Dayspring Primary, grades K–2; Dayspring Elementary, grades 3–5; Dayspring Middle School, grades 6–8; Dayspring High School, grades 9–12; and Dayspring Alternative School, ungraded. At the time of the study, the primary school had about 400 students, the majority of whom were from low-income families, and 24 teachers. About 53% of the students were on free or reduced lunch. About 69% of the students were white; 29%, African American; 1%, Asian; and 1%, Hispanic. Each year, many students moved into or out of the district. The school had some relatively affluent students, but these were mainly from the lower middle class. There were 6 classes of second graders with an average of 19 students in each class. The school had block scheduling of classes. The teachers at each grade level had a period during the afternoon to meet together to plan lessons and activities and to compare their students' work. The school system had previously adapted mastery learning, but new standards were imposed on them by the state during the year of the study.

Participants[1]

The team in this study was the only second grade team at Dayspring. Team members included individuals of different ethnicities, years of experience, and perspectives on teaching and learning mathematics. The professional development program lasted 2 years, with data collection starting in the second year. During the first year of the program, the professional developer met with the teachers once a month over a period of 4 months to plan, observe, and critique the teachers' mathematics lesson. At the end of the first year, one of the six teachers became a part-time third-grade teacher, and another teachers, Linda, was promoted to vice-principal of the school. Two teachers, Ivy and Mary, replaced them in the Grade 2 team for the second year. Data for this study was collected during the second year of the program. Altogether, six teachers and the assistant principal participated in the study. They were Mary, Ivy, Kay, Lana, Macy, Anna and Linda.

[1] This section appeared in Cheng &Ko (2009; 2014)

Distribution of Students

As was typical in this school, two of the six classes had relatively more advanced or gifted students, and the two teachers of these classes, Mary and Lana, collaborated with another gifted education teacher in the school. The rest of the classes were more or less evenly populated by high-, medium-, and low-ability students. A special education teacher in the school worked with the special education students. Most of the classes had one or two special education students, but Anna's class had more because the special education teacher had requested that certain special education students be placed with her. During the second year of the program, Anna's class had a good deal of movement in and out. Some of the high-ability students in the class transferred out of the school, and the students who entered were of lower ability, so the class ended up with more lower-ability children.

Data Collection

The sources of data were interviews and researcher's field notes. At the end of each laboratory class cycle we would observe one mathematics lesson for each teacher. Altogether, 49 interviews were conducted for the study. All of the individual interviews with the teachers were face-to-face interviews which lasted approximately 40 minutes each. Levin (2003) claims that performing specific dialogues is more effective in promoting dialogue than discussing the evaluation of the class. He refers to the process as a "clinical interview protocol" and says that its purpose is to examine and expand a teachers' thinking, recommending that dialogues with a teacher should be keep concrete with a protocol playing the role of a catalyst for thinking growth. Hence, we used semi-structured interviews which provided topics and questions to the interviewee but which were carefully designed to elicit the interviewee's ideas and opinions on the topic of interest, with the goal of leading the interviewee toward reflective thinking during the interview.

Baseline data about the teachers' beliefs in teaching and learning mathematics, their approaches to teaching mathematics were collected in the first interview. To capture the teachers' reflections on the learning acquired from the program, one interview was conducted after the program ended. An interview was conducted with the participant at the end of each laboratory class cycle. Altogether, six laboratory class cycles were implemented in this study.

Table 1 shows samples of the interview protocol. The transcripts of the interviews and the field notes were analyzed extensively. Pseudonyms were assigned to the school and the participants in order to ensure confidentiality.

Table 1.Sample of interview questions

Describe your reactions to the planning of the mathematics lessons.
Describe your reactions to the observation of lessons
Describe your reactions to the critique of lessons.

Data Analysis

The data were analyzed using the constant Charmaz's (2000) comparative method. In this study, we compared incident with incident to analyze the teachers' reactions to the laboratory class. We also compared data from individuals with data from themselves at different times to trace the teachers' conceptions of their change in learning and teaching. During the analysis process, we read the interview transcripts to give us anoverall sense of the participants'reactions to the laboratory class cycles, and we identified key teaching and learning experiences during the professional development program that appeared in their data. Four stages in the constant comparative method were employed. In Stage 1 of the constant comparative method, we coded the teachers' reactions and identified key elements of each learning episode. Using those codes, we formed many categories of analysis. Some of the categories were as follows: persons involved nature of activity, setting and timing of the episode, participants' immediate responses, participants' reflections about the experiences and beliefs, and long-term outcomes for the participants. Next, we compared the items within each categories across the teachers' experiences to trace their learning and teaching during the program and how it evolved. In Stage 2 of the constant comparative method, we continued to include more data sources to continue to categorize each mathematical experience. In Stage 3, we focused on applicable incidents, and stopped coding saturated categories. At the theory level, with the theory solidified, and connections and uniformities in the categories and properties emerged. In the last stage, Stage 4, we started writing the theoretical framework using our memos to provide the content behind the categories and their properties. We had a workable theory, and we proceeded to develop hypotheses as a result of the framework to explain certain social processes and their relationships.

FINDINGS

The school system had adopted mastery learning before new standards were imposed on them by the state during the year of the study.

> We had a couple of the teachers who were very old, very traditional in their views. They really depended on their paper-and-pencil tests. They depended on the right answer. They depended on students sitting in their seats being quiet and doing their

> work, turning to the page in their workbook and completing the work. (Linda, first interview)

Dewey thought highly of active participation in the activities of a community and of accepting the results of guided activities. He believes it is important to consider the subject in a community in teacher education preparations. At the same time, he emphasized that critical discussions should be performed to obtain educational results. According to Dewey, planning should be based on pedagogical theories, observations, and discussions (Dewey, 1904).

In preparing a lesson on measurements using a ruler, the team was asked how their students would measure a given object if the object was not placed on the zero point. The teachers remarked that they had never thought about using such a question to open up students' thinking. Anna and Macy remarked that sharing ideas about teaching a specific mathematics topic provided them the opportunity to learn "newer methods of teaching" from the younger teachers.

Lana said that the planning sessions provided a platform for team members to communicate, understand, and appreciate each other better. As an example she said that she had believed Macy used only drill and practice in teaching mathematics. Lana thought that Macy's students would be seated at their seats working through traditional drills and practicing problem after problem. Thus, she said, her team members were amazed to discover during the planning sessions that Macy had many creative ideas about teaching mathematics. This made Lana realize that a teacher who believes in the use of drill and practice in teaching mathematics can also teach creatively.

Linda said she thought that the teachers had improved in planning lessons. She said, the teachers thought more deeply about how to conduct a mathematics lesson and about the types of activities to include in the lesson beyond what the workbook offered. The school had been using a mastery-learning approach for several years. Linda thought that mastery learning was "where you were taught an objective … given a paper-pencil test, and if you didn't pass it, … you were re-taught it." She said she thought that the teachers who had used the mastery learning approach for several years were the ones who changed the most in terms of planning for mathematics lessons. She thought that those teachers had depended heavily on drill-and-practice activities. Now, more questioning and students' explanations could be heard in these teachers' mathematics lessons, and the students took more active roles in their learning.

As the data suggest, the planning phase provided the teachers a platform to develop and strengthen skills and the disposition to study and improve teaching. By sharing and honing such skills as a team, team members assisted one another in understanding the changes and in figuring out how to apply those changes.

As described above, a community for school-based teacher education operates flexibly,

with its basic objective being the improvement of professionalism. As Dewey (1904) recommended, in the planning phase we did not propose teaching materials or methods in excessively meticulous ways or make too frivolous or immediate criticism, but we did encourage teachers to give creative advice on preliminary preparations. Supporting such a community required, first, decisions about class schedules and content along with the sharing of individual experiences and data regarding class contents in conflict-free dialogues. It also required discussion of the specific contents that would be taught, the teaching methods to be used in the laboratory classes.

The professional development program was designed to offer experiences that could promote reflective thinking and contribute to the growth of those experiences. In other words, the program was designed to gradually develop the teachers' pedagogical knowledge by basing their learning on their current experiences. This meant it was necessary to use a somewhat artificial program to explore and develop solutions based on the teachers' current experiences rather than their past ones.

> If we attempt to gather together the points which have been brought out, we should have a view of practice work. At first, the practice school would be used mainly for purposes of observation (Dewey, 1904, p.26).

Accordingly, a laboratory class with participant observation can be thought of as an alternative approach. Such a class has different characteristics from a demonstration class. The existing demonstration classes were used for teachers to learn from the teaching methods or contents of excellent teachers or to present or offer new knowledge to the teachers.

It helped the teachers develop their questioning skills to have students explain their solutions even when they were incorrect

In the fourth observation session, food coloring was used to color water so that the children could read the water level in the measuring pitch. The use of the colored water activity had a big impact on the teachers. They had never considered that coloring the water would enhance the students' ability to read off the amount of water in a container. Macy said, "The color helps them see things. It [makes] it more visual to it." Ivy said "What the blue water experience represents to me was that you think outside of the box." Lana said, "I'm just learning that there are different ways to get there…and there are more ways to get there." Anna said, "I am able to think about the different things I am teaching in another way, using another approach instead of the same things that we have been doing for the last 15 years…try something new." This incident provoked the teachers to think about teaching and learning mathematics from the students' perspective.

Macy said that she had picked up a number of ideas for teaching time from the second observation and that these ideas helped many more of her children differentiate between the minute and the hour hands. That experience left a deep impression on her.

> You used two circles: one for the hour hand and the outer circle for the minute hand. And this gives the students something concrete to work on. That was good for me because it's very confusing to get all those hands. I am learning another way to have my children understand those hands (Macy, fourthinterview).

Reflecting on their beliefs about what should be taught to the students; they said that knowing why mathematics works would help students later use the mathematics they had learned. As the data suggest, the observation phase provided the teachers a platform to re-examine their deep-seated beliefs and practices in teaching and learning mathematics. We view the observation phase as an example of assisted performance because the teachers were assisted by the students and by the professional developer to learn and grow.

Dewey worried about the danger of a model or demonstration class, since he thought such classes for teachers might lead to an intellectual dependence among them:

> The "model lesson" of the teachers' institute and of the educational journal is a monument, on the one hand, of the eagerness of those in authority to secure immediate practical results at any cost; and, upon the other, of the willingness of our teaching corps to accept without inquiry or criticism any method or device which seems to promise good results. Teachers, actual and intending, flock to those persons who give them clear-cut and definite instructions as to just how to teach this or that (Dewey, 1904, p.16).

The laboratory class was different from the demonstration or model class in terms of its meaning and content. It represented an attempt to connect a teacher's teaching with her critical thinking, not simply to teach the teacher by offering excellent examples. Accordingly, the observations in a laboratory class have a different meaning, as Dewey noted in his remarks:

> Observation should at first be conducted from the psychological rather than from the "practical" standpoint. If the latter is emphasized before the student has an independent command of the former, the principle of imitation is almost sure to play an exaggerated part in the observer`s future teaching, and hence at the expense of personal insight and initiative. What the student needs most at this stage of growth is ability to see what is going on in the minds of a group of persons who are in intellectual contact with one another. He needs to learn to observe psychologically—a very different thing from simply observing how a teacher gets "good results" in presenting any particular subject (Dewey, 1904. p.19).

During the critique, the teachers discussed how the lesson might work if they were to try it again. Lana said that she would first ensure that students were familiar with the splitting of numbers and their representation before conducting the lesson about number bonds. Anna remarked that it was the critique about the "problematic lesson" afterwards that convinced her to improve her teaching by trying new ideas and to be more exploratory in her teaching. She said the fact that the team members were able to critique the lesson without attacking someone else's beliefs or ideas assured her that it was safe to

express her own thoughts.

Below is a conversation during the last cycle where teachers discuss games to reinforce multiplication facts.

Linda: Some students have difficulties seeing the pictures and I have to count for them.Some classes I did not do this activity. In some other classes I did another activity called the multiplication buzz.

Ivy: This is hard.

Mary: I am trying to figure out what is going on.

Ivy: She doesn't say 2; she says buzz.

Mary: They don't say the number that they are counting by...

Kay: We used to play that, and sometimes we play that with cards.

Macy: And you can make it real hard if you make buzz …

Linda: We play popcorns, families like that and then they say pop after a word, that's where they say popcorn and had to sit down.

Developer: How can we modify this game?

Macy: I'll be honest with you, when I get my children the next day to work on some of those; it is just like they were clueless. It was just amazing it just didn't click for them … I want one of those sheets of paper we did in the little group with the little boxes on there… they need additional practice on seeing that it is repeated addition.

Developer: The basic concept.

Macy: Yes

Kay: One way you can modify the game: the first time you play … give everybody a number … line [the numbers] up … this person is number 1, [that person is] number 2 and number 3 and [the children] hold [their numbers]… [For] multiplies of 2 … they hold [numeral] 1 up and put [numeral] 2 down. This person is 3, but you hold up … do that a couple of times and then say "OK this time, when we get to you, don't say 2, say buzz" …

Macy: And they could sit down …You can … line them up … if you are doing by 2, you go 1, and the 2ndperson … sit down

Linda: And actually they can hold the cards in their laps and if anybody is looking, they could see everybody seated 2,4,6,8,

Anna: And hopefully they will pick up the concept …and start looking for patterns…

As the discussion abovesuggests, the critique phase provided the teachers a platform

to strengthen their skills and their dispositions to study and improve teaching.

DISCUSSION

Professional Development Program

A previous study showed that attempts to learn new teaching methods or to teach students using the methods are affected by the existing knowledge about teaching and beliefs about the learners (Borko& Putnam, 1996). This may be because new information is filtered by existing ideas, resulting in an intuitive image. Such beliefs will function as filters in teachers' learning as well. One important role of a teacher is to examine how beliefs change in response to a professional development program and its activities, that is, to perceive the changes in teachers' thinking.

Using Green's (1971) and Rokeach's (1960) concepts of belief system, Thompson (1992) described a belief as an aesthetic, conceptual, planned, regular or spiritual image. After all, the learning and knowledge of teachers generate new knowledge by integrating it with existing knowledge (Franke, Carpenter, Levis &Fennema, 2001). Talking with teachers about their expectations of and experiences with their professional development is an important way of understanding the changes that such development brings about in the teachers. Furthermore, if a program is performed without regard for teachers' expectations and predictions, it will lessen teacher learning (Wilson& Berne, 1999). Thus, in carrying out the program it is important to monitor and evaluate the professional development needs and expectations that a teacher has at the moment (Glover & Law, 1996). Accordingly, it is important that the community evaluate the program and establish the direction of development in addition to sharing the experiences of teachers.

The three components of the professional development illustrated here —planning, observing, and critiquing by the professional developer—all supported the teachers' learning. The teachers and sometimes the professional developer volunteered to provide the resources during the planning sessions. Specifically, in this study the planning phase provided the teachers an opportunity to anticipate how the students might respond to the questions posed by the teachers and how the teachers might want to use the students' responses to continue with the instruction. The observation phase allowed the teachers to confirm their speculations concerning how the children might respond and react to the questions and to the developer. The critique enabled the teachers to share and extend these experiences by anticipating how other students might react and respond to the lesson. In this study, the teachers received assistance from a variety of sources, as mentioned in earlier paragraphs.

The tendency of educational development to proceed by reaction from one thing to

> another, to adopt for one year, or for a term of seven years, this or that new study or method of teaching, and then as abruptly to swing over to some new educational gospel, is a result which would be impossible if teachers were adequately moved by their own independent intelligence (Dewey, 1904, p.16).

Dewey said that a teacher needs to have two bases because the teacher's personal experiences alone do not make it possible to develop both theory and practice. These two bases are, first, subject matter and, second, educational psychology and philosophy. According to Dewey, the two can be formed from the teacher's inspiration and intellectual training. Furthermore, an environment should be provided that makes observation possible in order to nurture insight and to improve reflective thinking. In other words, the two bases can be formed, when observation is made within the teacher's practice and is supported for the purpose of drawing out his/her re-response.

In this section, we consider further what it might mean to view the laboratory class cycle as an opportunity to change through assisted performance. Overall, the teachers commented that the program led them to reflect on their practices, construct new knowledge about teaching, and make instructional shifts. The teachers sought the best strategies and instructional practices with which to engage students in learning. The teachers believed they became more effective, and they felt empowered to make deliberate and thoughtful changes in their lessons. The teachers also appeared to have developed an embrace of change that led them to reflect continually on their teaching and to experiment thoughtfully with new practices. The teachers' comments led us to conclude that certain aspects of the program made the teachers more willing to collaborate as a team, to learn, and to change. We claim that the following enabling factors are necessary before assisted performance is possible in a laboratory class cycle.

Structure for Teacher Growth

The laboratory class cycle provides a structure for teacher growth. The structure set up the learning, gave the teachers the tools they needed, and allowed them to try out the tools. In particular, the observation phase in this program was crucial in modeling focused questioning skills and in probing the students' responses to the teachers to find insights that could be used in further instruction. The structure of the program provided assistance to the teachers and gave them the confidence to try the lessons themselves.

The procedure for carrying out such a class is as follows: First, the class should be prepared through prior agreement based on the teaching experiences of each teacher because the class is an attempt to connect the teachers' primary teaching experiences with their secondary ones. Second, the class seeks continuity in their experiences by offering participatory observations. Third, the class seeks to develop the teachers' reflective thinking though critical post-class discussions, applies the results of laboratory class to

the teachers' classes, and shares the feedback on such applications. The quality and role of teacher education was not focused on the visible contents in experiences, but depends on the meaning and growth of the experiences.

Safe Environment and Support from School

Dewey believed that schedules should be focused on teachers, not the university educators. In other words, his rationale focused on flexibility. Dewey's greatest characteristic is the very flexibility in all the factors in a laboratory school for verifying his theory and practices, i.e., teachers, equipment, space, programs, schedules, etc. (Baker, 1955). Dewey's philosophy stressed the circumstances that may occur at the moment as well as the importance of alternative selections. According to Dewey, aims should be decided according to circumstances. In other words, he believed that objectives should be flexible (Dewey, 1944). Even if the things needed to verify hypotheses or practice principles—e.g., professors, tools, space, and time - do not follow fixed schedules and programs, this does not mean that such factors follow a random pattern (Baker, 1955). Understanding this will enable us to know how flexible we should be in operating a school-based community. We have emphasizeda flexible organization and structure that encourages original ideas and plans in operating a LCC.

The teachers were willing to participate in the program because the program was set up to allow the teachers to take risks and make mistakes without being ridiculed. Each teacher's input was valued, and a safe atmosphere was established in which teachers could re-examine their beliefs in teaching and learning. The school administrators were aware of what was going on in the program and of the importance of the program, which led them to work closely together to support the teachers and the professional developer. They ensured that the teachers were given their Professional Learning Units for participating in the professional development program and that the teachers had adequate time for the program. Linda said she made sure that the professional developer was given the necessary time with the teachers and that "the teachers were not tied down with a lot of other things to make sure that they could focus on the program." Linda said that one way she supported the program was by indicating on the school's calendar when the professional developer would be in the school.

CONCLUDING REMARKS

> Guided learning is easier to talk about than do. It takes clinical judgment to know when to intervene. Successful teachers must engage continually in on-line diagnosis of student understanding. They must be sensitive to overlapping zones of proximal

> development, where students are ripe for new learning. Guided discovery places a great deal of responsibility in the hands of teachers, who must model, foster, and guide the discovery process into forms of disciplined inquiry that would not be reached without expert guidance (Brown, 1992, p. 169).

By the same argument, teachers also need guidance in their learning and teaching. In this study, the guidance was provided by assisted performance. It is also the case that programs should promote deep-rooted changes in teaching instead of focusing on the mastery of specific routines. Introductory in-service workshops would not be sufficient to effect these meaningful changes shifts in practice (Borko & Putnam, 1996; Butler, Lauscher, Jarvis-Selinger & Beckingham, 2004; Perry, Walton & Calder, 1999). What is required are ongoing opportunities to co-construct knowledge through reflection on experience.

The laboratory class cycle is one professional development model that can help teachers cope with and change in response to change over an extensive period by providing guided learning through assisted performance for teachers. According to Smith (200**1**), a mathematics teacher's objectives should be to create mathematically strong students who can communicate with teachers or colleagues about mathematics, to be able to dispute with self-confidence, and to be able to solve problems that require composite thinking and deductive strategies alone or with colleagues. To achieve such goals, a teacher needs to make an effort, but making an effort may not be sufficient by itself. Hence, the program's goal is to help a teacher perform activities that will make such efforts effective.

The goal of the professional development program for teachers is not to present deeper knowledge or technologies useful for teaching; rather, the ultimate goal of the program is to understand students' circumstances and to be able to lead the students to teaching outcomes that are desirable according to Dewey's ideas of value standards and that are based on the current teaching experiences. Dewey said that by building up abilities through psychological observation and interpretation it becomes possible to make more technical observations concerning various methods or means for teaching. Accordingly, the programs should offer psychological participatory observation and its interpretation. "If properly prepared for, this need not tend to produce copiers, followers of tradition and example. Such students will be able to translate the practical devices which are such an important part of the equipment of a good teacher over into their psychological equivalents; to know not merely as a matter of brute fact that they do work, but to know how and why they work" (Dewey, 1904, p. 19).

Dewey (1944) emphasized the importance of active quest, speaking highly of the environment in which one can think in such a way. Priority should be placed on an educational environment which allows members to participate jointly, being connected with one another by certain common activities. To this end, the environment should raise issues for new quests and lead to efficient responses that are fully connected to the existing habits.

Working from such considerations, this study presented a laboratory class using current teaching objects and activity types through the university-connected community. The important role of the class lies in the linkage between theory and practice, the verification of theory in practice, and the development of reflective thinking. However, the reflective thinking itself is not a final goal of a teacher's professional development, but only a tool or medium to transform into a practical theory based on unripe experiences. Hence, a teacher's reflective thinking is a driving force to apply a valuable theory to his or her practical class and to develop the class (Dewey, 1904). In conclusion, we confirm that teacherswould be independent critics who can make a reasonable application in their class through a school-based training in reflective thinking.

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