IJACT 18-4-17

Changes in Classroom Actions of In-Service Middle School Mathematics Teachers Due to Self-Evaluation

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Abstract

This research examines the impact of teachers' self-evaluation on their classroom interactions with students. Changes in class behavior were analyzed by following two experienced middle school teachers for one semester of self-evaluation, comparing their classes at the beginning and end of the semester. A qualitative research method was adopted to take, a deeper look at the effect of changes in the teachers' in class actions. Both of the teachers reported positive effects of implementing self-evaluation on their teaching pedagogy, focusing specifically on their interactions with students when asking question and giving feedback. By the end of semester, they were asking broader questions that encouraged their students to engage in deeper thought and, when giving feedback, the class atmosphere was much brighter with better communication due to the positive reinforcement provided. This research supports research into ways to enhance teachers' expertise and improve their teaching via self-evaluation, centering on teachers' actions in the classroom.

Keywords: Class actions, Self-evaluation, Acts of question and feedback

1. Introduction

The quality of education depends on classroom teachers. Feldman([4]) argued that, `There is no more important factor than the quality of classes in determining the quality of education, and in determining the quality of the class there is no more important factor than the factor of the teacher.' It is also true that high quality education begins with a teacher who has highly elaborated and refined teaching skills. Such ability is known as `teaching professionalism'([19]).

Teaching professionalism may not come solely from nature; nurture also plays a major role as it depends on the effort the teacher puts into it. The best teachers try to identify any problems in their classes and do their best to correct them. As part of the effort to raise the level of professionalism in the classroom, teachers are required to do research and develop their own pedagogy. It is also important for a teacher to explore ways to manage their classrooms, efficiently and effectively in any educational situations they may confront. Such activities are supported by the professional development sessions offered by teachers' associations and subject group meeting within schools. This process is not necessarily expensive or disruptive; teachers could think about activities that are already part of the everyday routine in their classrooms. A teacher practicing good teaching professionalism should be able to make their classes more effective by implementing more positive

interactions with their students, for example by utilizing high quality educative materials and effective teaching methods that are tailored to the needs of each student, thus promoting the all-round growth of their students([19]).

There are many ways for a teacher to develop their teaching professionalism. Of these, engaging in the self-evaluation of classes through reflective thinking can yield valuable insights that help teachers grow their professionalism. Traditionally, teacher training has placed a strong emphasis on teachers' self-reflection and a teacher's self-evaluation of a class is known to be another important factor contributing to improving their teaching professionalism and having their professionalism as a teacher acknowledged([22]). The most important object of self-evaluation for a teacher is their teaching practice. By self-examining every aspect of their teaching activities, teachers gain unique practical knowledge that they can apply to enhance their teaching professionalism. This sort of self-evaluation thinking encourages teachers to think deeply about what happens in their classrooms, influencing them to improve the quality of their teaching and helping to build a more meaningful class([18]).

Lee([10]) emphasizes the importance of self-evaluation for classroom teachers as a way to enhance their teaching professionalism. We believe that if a teacher performs self-evaluation regularly after teaching classes, they will identify any problems, recognize the structure of the problem, and restructure it in the form of a hypothesis. Then, in a situation of practice, by seeking to verify that hypothesis, they can create new understandings and applications and thus improve their teaching effectiveness. This type of self-evaluation of teaching activities becomes more meaningful as the effectiveness of the self-evaluation of teaching is proven and the teacher grows more confident in the value of this approach. Thus, this study seeks to understand how class behavior changes over the course of the semester due to a teacher's self-evaluation in middle school math classes. To investigate the effect of the participating teachers' self-evaluation, we conducted regular interviews with them and observed their classes at the beginning and end of the semester via video-taping to identify any changes in their classroom activities. Based on the interviews and class observations, we were thus able to examine how the teachers applied and were influenced by the results of their self-examinations.

2. Literature Review

2.1. Self-evaluation of classes

Classroom teaching is at the heart of all school education, and the classroom is where the most important process of all educational activities occurs. Once the course objectives have been set and the teaching material chosen, a class will process accordingly. As a result, course objectives aligned with the curriculum are eventually achieved within the process of the class. At the end of a class, the efficiency and effectiveness of school accountability are assessed. Given that classroom teaching is the most important process of school education and hence key for the entire education process, it follow that the importance of classroom teaching should be recognized and supported by improving teaching pedagogy. It is therefore of the utmost importance that teachers exhibit teaching professionalism, thus raising the quality of the instruction they deliver. In the classroom, no one is more aware of this than the teacher so they are best-placed to apply their theoretical and practical knowledge to solve the complicated problems that arise in their classes. As part of this effort, they also need to be researchers who understand their students and can thus identify ways to improve the quality of the education they deliver. This means that, teachers can not simply be passive observers in their classrooms and school but instead need to engage in self-critical reflection from a wider social and cultural perspective([1]).

A teacher's self-reflection has as its primary goals raising the quality of a class and, ultimately, enhancing the teacher's teaching professionalism. Self-evaluation allows the teacher to think back over what happened in a class, assess how well it went, and consider ways the instruction they delivered could have been improved. With self-realization, they acquire the techniques to accurately assess their own classes and develop the ability to enhance their teaching skills. This process also encourages teachers to take more responsibility for their students' achievement([16]). Yoo([21]) states that the concept of teaching professionalism includes all activities that ultimately improve their classes and include teachers reflecting on the value and meaning of their classroom activities, and implementing a series of steps to enhance the atmosphere and improve behavior in their classes, resulting in better students learning.

Schon([17]) considers Dewey's concept of self-evaluation thinking a useful basis for the concept of professional expertise, arguing that reflection is a method of thinking and acting that is naturally performed by an expert. Therefore, an expert could be defined as someone who consistently reflectively thinks about and practices dealing with difficult professional situations, including conflict, distinction, and uncertainty. Acts of practicing, handling uncertainties, and solving problems in professional situations are key aspects of Schon's concept of reflection. Self-evaluation is not only a method of enhancing discussion making abilities and supporting autonomy, but also the core component and very important factor or characteristic regulating an excellent class. Regularly engaging in self-evaluation of their classes allows teachers to take a deep and close look at their teaching behaviors, and provides valuable feedback about their teaching methods([7], [12]). A teacher needs to implement reflective techniques to examine their teaching methods if they are to engage in teaching activities as a reflective participant and develop their teaching professionalism. This process of self-evaluation thinking related to a teacher's analysis of their reflection on their classes enable them to analyze their actions or beliefs in a number of different ways, thus revealing common points that could suggest a change in actions as well as providing opportunities for looking back at their actions during class and situations that arose during the process of the lesson and consider how they could have been done differently to give a better outcome. In this study, we took a close look at the classroom activities of two in-service middle school mathematics teachers to determine whether self-evaluation had any impact over the course of the semester.

2.2. Class behavior

In class a teacher directly or indirectly influences students' learning through various class inter-action. A teacher's class behavior should promote a student's learning and enable them to achieve cognitive learning. In the classroom, a teacher's class behavior consists of the series of teaching activities conducted during the class and includes all the interactions between the students and the teacher. All actions by a teacher in class should be directed towards achieving the learner's academic goals and they are important factors in determining the class's quality. Lee([11]) describes class behavior as being all of a teacher's actions designed to exert academic influence, such as character, attitude, values, and intellectual abilities. This covers all of a teacher's actions and forms of behavior and suggests that the teacher's class behavior can improve a class's quality and is an important contributor to class effectiveness. The teacher's class behaviors will thus be an important part of assessing the quality of a teacher's class. Consequently, many studies have examined the impact of teacher's class behavior, focusing particularly on the influences of a teacher's talent and characteristics, the impact and effectiveness of various teaching methods, and the factors related to teaching behavior.

Kim([8]) conducted an extensive review of studies of the teaching methods utilized by effective teacher's and concluded that these can be summarized as providing clear explanations, repetition of important contents, revealing the relationships linking the class content, systematic progress of the class, various teaching methods, the usage of diverse question types, variety of data, encouraging students' opinions, usage of students' opinions, a passionate attitude, and providing learning opportunities. Cruickshank([3]) listed seven teaching techniques used by effective teachers: concentrating the students' attention, using a variety of teaching methods, efficient use of class time, using questions, providing a clear class, inspecting students' learning progress, and providing feedback. Hoffman([5]) described the characteristics of an efficient class as consisting of knowledge and capability, clearness, activities that promote and strengthen participation in class, not permitting students' mistakes, variety, students' participation, and an interest and satisfaction of the class. Although these scholars have placed different emphases on effective class behavior, the common underlying factors are generally clearness, interactions with students, and questions. Most class activities are made up of three steps: introduction, development, and organization. The introductory step of the class is primarily to establish the objective of the class, the developmental step is made up of lots of questioning acts, and in the organizational step the students' responses are checked and feedback is provided. Consequently, for this study of teachers' class behavior we chose to examine the changes that resulted from self-evaluation by focusing on the type of questions the teachers asked and the feedback they provided to their students.

The act of questioning can be defined as a type of sentence designed to evoke a response, an expression made by an individual to clarify information, or an expression or sentence pursuing information. A teacher will ask a question that encourages students to directly interact with the content that had been taught. An

example of this method is in a case where the teacher asks students a question to see if they have understand and can remember the content presented in the textbook. The questioning technique is generally considered to be an important skill that a teacher should have, and the diversity of the questions asked by the teacher will depend on how flexibly the teacher uses those questions. The question itself should not become the goal; the question is of more importance when during the learning process it provides the learner with an opportunity for an activity or actual practice, or serves as a method of active participative thinking within learning([9]). A simple classification of questions determines whether they are expansive or collective: a collective question only has one answer, where as an expansive question can have many answers([10]). Questions can be linguistic actions that teachers use to obtain information regarding how well students have learnt the content, to stimulate students' thought processes, and to increase participation in a learning activity. Asking questions is the basis for effective communication, and as a key part of teaching interaction should be conducted at an adequate level in an appropriate form. Above all, it should be adequately expressed([13]). We therefore examined how the teacher's form of question changed after self-evaluation of classes.

Feedback is the information sent back to the students on an individual basis after individual activities or proper responses. Feedback is one way of communication and interaction with students, acting as a control function. In an educational setting, any form of communication used to provide students with the quantity or quality of student's learning is referred to as feedback([15]). Feedback can also be seen as an active response to students' actions in the form of a positive reinforcement, and the effect of this feedback allows them to build confidence in their possibility of success in learning the content they are currently studying. By developing their techniques through the teacher's interactions with students or from data provided by the teacher, students learn of their level of accomplishment and this activity improves the quality of communication with the teacher about their achievement level([20]). Feedback plays an important role in motivating students to do their best, and there are three common techniques used to provide good feedback for students: compliments, rewards based on the outcome achieved, and the grades awarded. All these, should be provided in situations that clearly or are specifically related to a correct action or an action that needs reinforcement([14]). The feedback given to a student by the teacher also indicates whether the student's responses were appropriate or not, and the feedback from the student to the teacher then allows the teacher to develop a better understanding of the student's responses. This continuous interaction between students and teacher lies at the heart of teaching([2]). A teacher's feedback can be divided into three types: positive reinforcement feedback, negative reinforcement feedback, and simple forms. In this study, we also examine how self-evaluation changes the feedback provided by the teacher.

3. Method

Applying two qualitative research methods: participant observation and in-depth interviews, we examined the effect of the participating teachers' self-evaluation on their classes. Participant observations were performed by video-taping their classes at the beginning and end of the spring semester and conducting three in-depth interviews over the course of the semester to explore their understanding, planning, and strategies.

3.1. Participants

To select an appropriate sample, we applied purposive sampling with the following criteria: years of teaching experience(more than 10 years and similar experience among the selected sample); stability of teaching pedagogy(minimal modification of their teaching every year, assessed via oral interviews); teaching at a middle school; degree in subject(bachelor's in mathematics with some graduate course); participation in professional development in teaching(once or twice). Both male and female teachers were eligible for inclusion. Based on these criteria, we recruited two experienced middle school math teachers, P and L, currently working in different middle schools in the same city as our test subjects and they completed written consent forms. The concept and principles of self-evaluation of classes was explained to the participants and the way the video recording of the classes would be conducted to examine any changes in their teaching methods due to the self-evaluation of classes was adjusted to ensure it would not interfere and distort the study purpose. Teacher P teaches middle school students classified as low to mid-level for mathematics and Teacher L's middle school

students are classified as high level for mathematics; our student sample thus covers a full range of performance levels from low to high. Table 1 shows the research subjects' background.

Table 1. Participant demographics

Designation	School level	Class taught level	Teaching career(years)	Scholarly attainments
Teacher P	middle School	Grade 8	15	Coursework completed for doctorate
Teacher L	middle School	Grade 9	15	Coursework completed for masters

3.2. Instrument

A class session taught by each of the participating teachers was taped at the beginning of the semester, as well as another session of the same class at the end of the semester for comparison. Each class consisted of 8th Grade students and included both males and females. The teachers were asked to devote some time to self-evaluation immediately after each class. The tapes were then reviewed by the researchers and the questions asked and the feedback provided to students in the classroom evaluated. Asking questions gives teachers a grasp of their students' understanding and knowledge of the math content presented in class and can be used to induce the students to engage in mathematical thinking, thus increasing their interest in learning math. By observing the teachers' question-asking-methods, we were able to provide data on how effective the teacher's question levels and types are in supporting the students' math learning, class participation, and development of mathematical thought. We measured the frequencies of collective and divergent questions that were both valid and content relevant based on the data collected by video-taping the class sessions. Because a teacher's feedback in an actual class provides students with a learning outcome, this influences the learning process; whether the teacher's feedback is positive or negative will affect a student's interest and attitude toward math. Our observation of feedback provided by the teacher during the class thus provides information on how effective different types of teacher feedback were for individual students and the impact on the students' motivation to study math. An observation graph for feedback similar to that proposed by Joo et al.([6]) was utilized, comprising three fields: positive reinforcement feedback, negative reinforcement feedback, and simple forms of feedback.

3.3. Data analysis

We sought to identify any changes in the teachers' questioning actions or the feedback provided during class that represented differences in their teaching methods implemented as a result of their self-evaluation. To study the change in questioning actions we used collective questions and expansive questions for the conformity analysis and then divided the frequency of each by the total frequency expressed as a percentage. To clearly visualize the change in question-asking methods used we compared the results from the April and July class observations in the form of the both charts and graphs. The interviews with the participants were structured to facilitate our examination of any changes in the process of asking questions, allowing us to confirm whether the changes observed were indeed meaningful. To study the teachers' change in feedback we used positive reinforcement feedback, negative reinforcement feedback, and simple forms of feedback for the conformity analysis, once again dividing the frequency of each by the total frequency and expressing the results as a percentage of the whole. For the conformity analysis of each teacher's change in feedback actions, we compared the results from April and July class observations in the form of charts and graphs and, the interviews were also structured in such a way as to enable us to elicit more details of any changes in the feedback process.

4. Results

This research was designed to identify changes in the teaching-learning methods used in the classroom as a result of the teachers' self-evaluation of their classes, focusing specifically on changes in the types of questions teachers asked their students and the feedback provided during the class by the teacher.

4.1. Results for changes in question-asking behavior

4.1.1. Teacher P
Teacher P is an experienced teacher, having taught for 15 years, and is currently in charge of 8th and 9th graders in a middle school. The results of the change in the type of in-class questions asked between the first self-evaluation class and the end of the first semester is shown in Table 2.

Table 2. Comparison of the types of question-asked in teacher P's classes

Class	Collective questions	Divergent questions	Total
April	89.8%	10.2%	100%
July	80.2%	19.8%	100%

As the data shows, when P first started self-evaluation, collective questions made up 89.8% of the total questions asked, with only 10.2% divergent questions being posed. This shows that teacher P was mostly asking students collective questions with only one answer, with far fewer divergent questions that require students to think more as there is more than one right answer. However, by the end of the semester there was a marked change in the questions asked, with collective questions making up 80.2% of the questions asked and divergent questions shooting up to 19.8%. Although the questions being asked were still mostly collective in nature, the proportion of divergent questions had almost doubled.
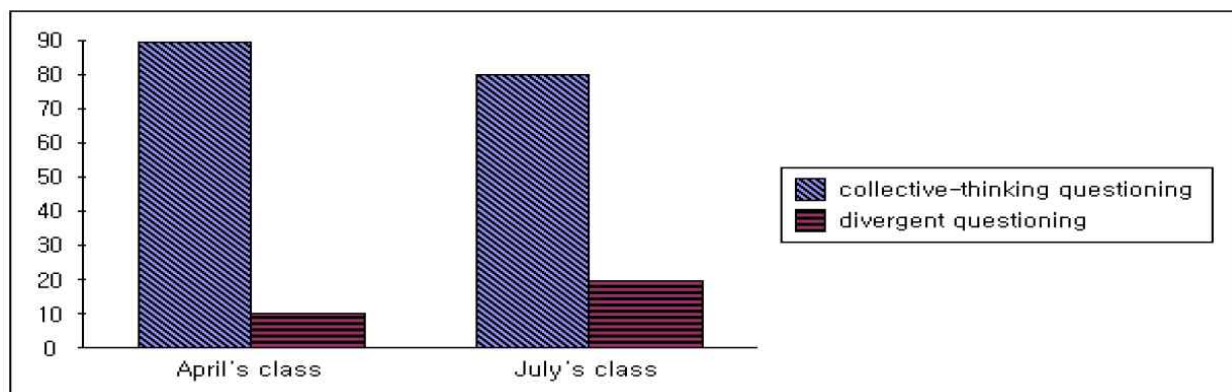

Figure 1. Graphical representation of teacher P's change in question Type

This means that P's self-evaluation had resulted in classes where the students were encouraged to think more about the class content, and the effort P put into preparing and then asking related questions was clearly visible in the change in the type of questions asked. To determine how P's perceptions of question asking changed and what sort of actions he actually practiced through self-evaluation, during the interviews P was asked `What sort of specific change about your perception of asking questions did you feel from reflecting on your own class? How did you actually practice change in asking questions during class?' As the semester progressed, teacher P's answers changed somewhat; at the beginning of the semester the response was `perception of question asking' in May, the answer was `self-evaluation is good,' and in P replied `I can definitely feel the change in asking questions.' Teacher P's detailed responses to this part of the in-depth interviews regarding the

change in question asked is shown below:

> The important thing is that asking questions was not something I used to think about, but now I do. Specifically I have started to ask the students about even trivial things. The students' participation rate has increased and they are more interested. I am glad that I think about it now, although I used to be indifferent towards asking questions. The students have a higher level of concentration and I feel that it is necessary because it results in a higher level of satisfaction. (Teacher P, April interview)

> The thing that has definitely changed is that by writing down what I reflect on after class that part seems to continually get better. By continuously taking the time to self-examine after the first class, I think it definitely has an effect for the next class. I hadn't reflected on some parts that could be fixed but now I can _find parts that I feel I could have done better and I am able to fix them for the second class. (Teacher P, May interview)

> I have definitely found a change in asking questions. After I started to think that preparing the questions beforehand was important, there were times when I would be flustered when I didn't get the answer I wanted but still overall it was very satisfying and when the answer I wanted did come out I would feel very happy and feel like I had planned the question well. (Teacher P, June interview)

The interview questions we asked teacher P at the beginning of the semester about asking questions drew P's attention to the importance of asking questions and encouraged him to implement changes in the type of questions asked. Asking different types of questions led to changes in the teacher's class behavior and consequently the students' concentration and increased their satisfaction with the class, indicating that the level of professionalism P demonstrated in class also increased.
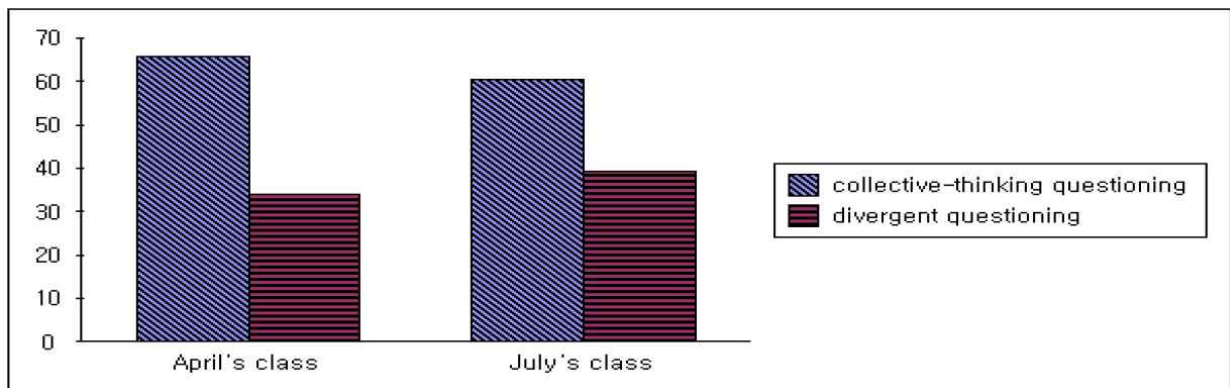

Figure 2. Graphical representation of teacher L's change in question Types

4.1.2. Teacher L

In-service teacher L also has 15-years of experience as a teacher and is currently in charge of 9th graders in middle school. The changes in the types of questions asked by teacher L between the beginning of the self-evaluation and the end of the semester are shown in Table 3.

Table 3. Comparison of the types of question-asked in teacher L's classes

Class	Collective questions	Divergent questions	Total
April	65.8%	34.2%	100%
July	60.6%	39.4%	100%

As the data in Table 3 shows, teacher L started from a different baseline than teacher P because even before starting the self-evaluation process, L asked collective questions 65.8% of the time and divergent questions

34.2% of the time. However, this still means that teacher L asked twice as many collective questions with only one answer than divergent questions with more than one answer that encourage students to think about the concepts involved more. Even here, though, there was a visible change over the course of the semester: by the end of the semester and after L's extensive self-evaluation, collective questions had dropped to 60.6% and divergent questions risen to 39.4%, much closer to parity. This suggests that through self-examining her own classes, teacher L had realized the importance of asking different types of questions and tried to vary the questions, thus facilitating for a change in students' understanding and attitude. This is clearly shown in the graph in Figure 2.

To see how L's perception of question asking changed and what sort of actions teacher L actually practiced through self-evaluation, in the interviews we asked `What sort of specific change about your perception of asking questions did you feel from reflecting on your own class? How did you actually practice change in asking questions during class?' Again, the answers changed as the semester progressed: in April teacher L answered `change in question asking', in May `should do more research on asking questions' and by the June interview L was noticing `the change in asking questions has led to a better class atmosphere'. The specific answers showing the change in teacher L's response is shown below:

> Usually when asking questions, I asked `What is the next step?' I realized that I should make my questions more varied so that the students can do more thinking than my usual question. The students' response is more active and the class atmosphere is very positive and active. (Teacher L, April interview)

> After seeing the students change to be more active I thought since I'm going to be doing this every year I should think more from the students' point of view and make an effort to research asking questions. And also since asking questions in math isn't very varied I should pay more attention. Since there aren't many ways to solve middle school math questions, instead of the first way shown in the textbook, I am thinking I should give them opportunities for looking for more ways by studying ways to ask the question and provide the answers. (Teacher L, May interview)

> First of all in math class usually when I start teaching they all look ahead and listen carefully to what I say. When I ask a question that doesn't have one answer, since this is a question they can answer with their thoughts, you could say that the atmosphere of the class is much positive and active. And the types of answers are more varied. (Teacher L, June interview)

Through the interviews with teacher L over the semester, we can see L has been trying to change and is realizing the importance of asking questions. The teacher's class behavior has changed due to asking questions, as L has tried to ask more questions where the students can think opposed to more simple forms of asking questions. Teacher L's self-evaluation of class has led her to improve the actual classes and is practiced often.

4.2. Results for changes in feedback provided

4.2.1. Teacher P
The results for the change in feedback behavior between the beginning of self-evaluation of class and the end of the semester are shown in Table 4 and Figure 3.

Table 4. Comparison of the feedback delivered by teacher P

Class	Positive reinforcement feedback	Negative reinforcement feedback	Simple forms of feedback	Total
April	14.5%	1.2%	84.3%	100%
July	20.3%	0%	79.7%	100%

When teacher P first started self-evaluation, the feedback actions being delivered were positive

reinforcement feedback 14.5%, negative reinforcement feedback 1.2%, and simple form of feedback 84.3%. This shows that teacher P was mostly giving students simple forms of feedback in class. However, by the end of the semester there was a clear change in P's feedback behavior. As a result of the self-evaluation, the feedback behavior had shifted to positive reinforcement feedback 20.3%, and simple forms of feedback 79.7%, with no negative reinforcement at all. This teacher's self-evaluation led to a significant increase in positive reinforcement feedback, thus enhancing the effect of the class.

Figure 3. Graphical representation of teacher P's change in feedback behavior

To see how self-evaluation changed teacher P's feedback behavior and perspective and what sort of actions were practiced to produce this change, in the interviews we asked teacher P `Through self-evaluation of class was there a specific change in your perspective of feedback behavior? What did you actually practice in class to change your feedback behavior?' In both April and May, teacher P answered `Students like a variety of feedback,' in May adding that `the change in feedback behavior has led to a change in the class atmosphere'; in June, teacher P answered `self-evaluation and development of feedback behavior.' The detailed responses given by teacher P about the change in feedback behavior were as follows:

> It is good that the feedback can be about oneself. The change in students can be confirmed and it is effective in drawing it out. `Since I asked, it is natural that they should reply' was how I always thought, but it was a good chance to think of how should I ask the question for a good reply, will the answer come out as I thought, or will the answer be close to being correct, which allowed it to go in a good direction. The fact that it became an atmosphere for a lot of conversation was positive. They might not have realized that the teacher was really trying but time for conversation got longer and the students' atmosphere was much more energetic, which is positive. (Teacher P, April interview)

> Since there are a lot of questions the students must solve and it is revolves around calculation I try hard to do a lot for them and when I help the students draw graphs or help them with difficult parts the response is really good. It may seem simple but easy things such as finding the inclination can sometimes be very difficult and when I give them feedback about these things they seem to do very well after realizing the principle. Before this whenever a graph came out they would stop trying, saying they don't get it, but after having feedback about this part there were a lot of students who were very confident about graphs. Also the students like various type of feedback very much. (Teacher P, May interview)

> I think feedback actually helps part of the class develop. When I teach them I feel somewhat confident about some parts but sometimes of the parts the students don't know very well or need help with, looking upon the result of that part I feel there are some unsatisfactory parts about feedback. (Teacher P, June interview)

Over the course of the semester, teacher P has realized the importance of feedback and we can see that through positive feedback the classroom atmosphere has become more energetic. This change in feedback behavior has led to a change in class behavior and provided the opportunity for the students to become more confident about math. Through self-evaluation, we can see that P's teaching of the math class has developed,

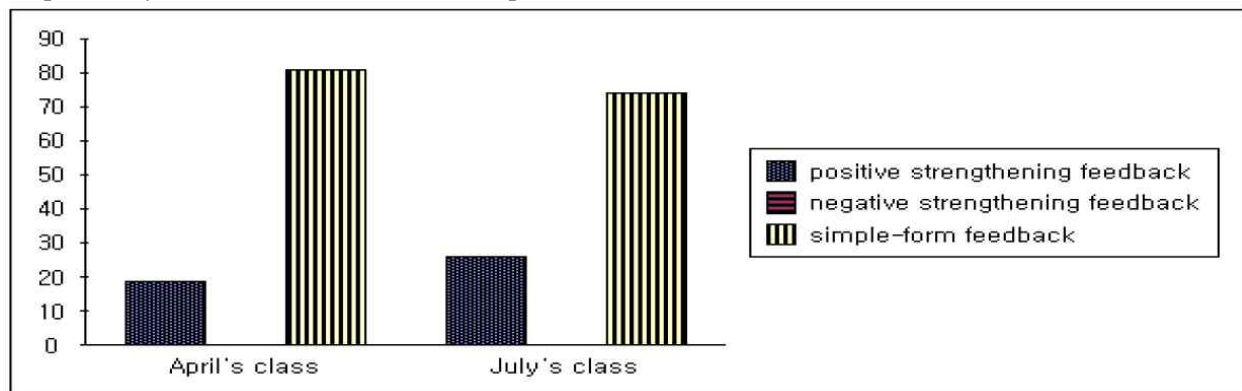accompanied by a clear increase in the class's professionalism.

Figure 4. Graphical representation of teacher L's change in feedback behavior

4.2.2. Teacher L

The results of the change in the feedback provided by teacher L from the beginning of self-evaluation to the end of the semester are shown in Table 5 and Figure 4.

Table 5. Comparison of the feedback delivered by teacher L

Class	Positive reinforcement feedback	Negative reinforcement feedback	Simple forms of feedback	Total
April	18.9%	0%	81.1%	100%
July	25.9%	0%	74.1%	100%

As the data in Table 5 show, when in-service teacher L first started self-evaluation, the positive reinforcement feedback being provided to students was 18.9% and simple forms of feedback 81.1%, with no negative reinforcement. As with teacher P, teacher L was mostly delivering simple forms of feedback in the classroom, but by the end of the semester, there was a clear change in teacher L's feedback behavior, with a marked increase in the positive reinforcement feedback, raising it to 25.9%, and a corresponding drop in simple forms of feedback of 7%. This shows that the teacher's own reflection led to an increase in positive reinforcement feedback, thus increasing communication with the students and creating a positive classroom atmosphere. To see how self-evaluation changed teacher L's feedback behavior and perspective and what sort of actions were practiced to produce this change, in the interviews we asked teacher L `Through self-evaluation of class was there a specific change in your perspective of feedback behavior? What did you actually practice in class to change your feedback behavior?' In April, teacher L responded `the positive feedback provides math class that students like', in May that, `the class atmosphere became positive and active.' and in June that, `good communication is possible due to positive feedback.' The specific answers given by teacher L about these changes in feedback behavior were as follows:

> This year since I had already told the students ahead of time that since I was doing this I was going to try and change the classes in a better direction, and maybe it was because they knew this, that I was trying harder, that they acknowledged `The teacher is trying to do something' and since they felt it too I think it gave a good influence on them too. I can't say there was no difference than before. That they knew that I was that much more interested in them and paid attention to them made the time warmer. (Teacher L, April interview)

> Of course it is to an ultimate. Even today I felt that I got to do at least one more thing for them, which made me feel happy, and as a teacher it felt very worthwhile. When I go to class and it is more energetic and everybody is happy, I think this is very effect for the children, and since the students are doing well it makes me happy. The atmosphere has become much positive and active. (Teacher L, May interview)

They accept me well and we all laugh over things saying I guess you could think so which allows me to transition to today's point naturally. Talking together a lot makes people closer and honestly in a classroom the physical space itself makes it hard to feel friendly one on one but with that class the atmosphere is good. The actual act of conversing doesn't feel very mathematical but comfortable. The communication is better than before. (Teacher L, June interview)

These interviews with teacher L over the course of the semester about the feedback being delivered clearly show that teacher L has experienced a change in the class. Changing the feedback has also changed the class atmosphere, making it more relaxed, and communication with the students has become more energetic. Through self-evaluation, the change in feedback behavior has led to a change in class behavior and many other aspects of the class have changed accordingly. Applying teacher L's own self-evaluation to real class time has also increased the level of class professionalism.

5. Conclusions and discussion

This study was conducted to identify any changes in a teacher's class behavior due to self-evaluation. After considering all the various class behaviors that could be affected by self-evaluation, we chose to examine the influence of self-evaluation on the types of questions teachers ask in class and their feedback behavior. We analyzed the classroom activities of two in-service teachers teaching mathematics in different middle schools before self-evaluation and after one semester of self-evaluation, and conducted a series of interviews throughout the semester to identify any changes in class behavior using high quality research methods. The self-evaluation of classes instigated a change in the types of questions asked by both in-service teachers, with a clear shift from collective questions to divergent questions. As a result, the students became more active in learning activities and the additional opportunities to think about the topics being taught gave the students more chances to widen their thinking processes. To accomplish this, the teachers changed their classroom behaviors by preparing suitable questions ahead of time. There was also a change in the feedback behavior of the two in-service teachers after self-evaluation. By the end of the semester, positive reinforcement feedback behavior by both teachers had increased compared to before the self-evaluation and simple forms of feedback decreased slightly. Self-evaluation led to changes in feedback and this in turn increased the teachers' positive interactions with the students, making the class atmosphere more energetic. This was accompanied by an effort to positively accept the students' thoughts and opinions.

Limitations. Due to the stringent selection criteria applied, our findings may not be applicable to all teachers in middle and high schools. Rather, the findings are valid only for experienced math teachers in middle schools. Although our findings are based on participant observation and in-depth interviews and were carefully conducted, the results may be different in other setting according to the cut-offs used to indicate the changes. Moreover, it would clearly be advantageous to expand the study to include a wider range of teachers. However, our results represent a pilot study that will serve as a useful guide for further research in this area.

Implications. To induce a change in effective class behaviors, teachers could benefit from thinking reflectively about their classes and looking back at their class behavior critically, thus enabling them to identify ways to improve their practice. By changing their practical class behavior, the teachers themselves can become teaching experts. For this result to be achieved, it is of utmost importance that teachers self-examine their own classes, reflecting on and analyzing their teaching activities and having the will to improve their classes. It would be helpful to encourage teachers will to improve their classes by providing supportive policies for faculty, for example by introducing as benefits towards personnel matters or extra points for promotion. Finally, there is a need for school curriculums to operate in such a way as to encourage teachers to voluntarily engage in self-evaluation to improve the quality of their classes, and for teachers' training to incorporate an effective model of reflective class analysis in order to increase teaching professionalism in a programs and thus increase teaching professionalism generally.

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