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Communities of Practice for Student Assessment in a South Korean Middle School

Heejung Min
Eonnam Middle School, Seoul, KOREA

Hee Jin Noh
Chemistry Education, Korea National University of Education, Cheongju, KOREA

Seoung-Hey Paik
Chemistry Education, Korea National University of Education, Cheongju, KOREA

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ABSTRACT

This study examined the interactions of teachers with different professional development (PD) backgrounds in communities of practice (CoPs) formed for student assessment in a South Korean middle school. We analyzed the teachers' collaborative and reflective processes regarding the development, implementation, and feedback processes for student assessment in two CoPs that each consisted of two middle school science teachers. Two different types of CoP were identified: a routine practice CoP and a challenge practice CoP. The routine practice CoP displayed weak interaction between teachers and poor PD, while the challenge practice CoP displayed stronger interaction between teachers and better PD. These two types of CoP were determined by the mutual respect between the teachers. The results of this study can contribute to the development of teacher PD based on its implications for forming teacher CoPs that induce the active participation of members and the formation of mutually respectful relationships among them.

Keywords: assessment strategies, communities of practice, professional development, reflection, science education

INTRODUCTION

Teachers must consider many factors to ensure the success of their students, such as the effect of student thinking and experience on achievement (NCTM, 1995). It is true that the teacher's role is important in facilitating student learning (National Research Council, 2012; Department for Education, 2013), and the effect of professional development (PD) and professional knowledge on teaching has received considerable attention from researchers (Cochran-Smith & Lytle, 1993; Gess-Newsome, Carlson, Gardner, & Taylor 2011; Hashweh, 2005; Lewis, 2011; Magnusson et al., 1999; Park et al., 2007; van Driel, 2010). It has also been the subject of case studies (Friedrichsen et al., 2009; Munby & Russell, 1994; Park & Chin, 2011) as well as ways of documenting professional development (Loughran, Mulhall & Berry, 2004; Nilsson & Vikström, 2015; Veal, 2002).

Teachers' professional knowledge is more influenced by collaborative interactions with colleagues than by independent practice in the classroom (Akerson et al., 2009; Flint, Zisook, & Fisher, 2011; Fultak & Heredia, 2014; Gao & Wang, 2014; Jones et al., 2013; Lewis et al., 2015; So, 2013; Rytivaara & Kershner, 2012; van Driel, 2010).

Correspondence: Seoung-Hey Paik, *Chemistry Education, Korea National University of Education, Cheongju, Korea.*
shpaik@knue.ac.kr

Contribution of this paper to the literature

- The teachers modified scoring rubrics to increase correct answer rates. This was because the consideration of colleagues' needs took precedence over the students' needs. The teachers had conflicts with one another but were able to resolve the issues that came up in the CoP. However, conflicts were only resolved when there was mutual trust and respect between the teachers.
- Two types of practice in teacher CoPs were found in the process of developing, implementing, and giving feedback in student assessment: challenge and routine.
- Teacher identification with CoPs and learning partnerships were observed only in the challenge CoP.

Therefore, it is essential to study teacher communities of practice (CoPs) in order to understand their influence on teachers' PD.

Teacher CoPs (Cochran-Smith & Lytle, 1999; Correa, Martínez-Arbelaiz, & Aberasturi-Apraiz, 2015; Wenger, 1998) have been called by different names, such as professional learning communities (Dooner, Mandzuk, & Clifton, 2008; Jones et al., 2013) and teacher learning communities (Gao & Wang, 2014; van Es, 2012). The common assumption is that teachers develop their professional knowledge through sharing lesson plans, instructional strategies, and discussion in the CoP (Garet et al., 2001; Gao & Wang, 2014; van Driel, 2010). Through participation in CoPs, teachers become both the researchers of teaching and learning and the subjects of developing professional knowledge gained through practice (Lytle & Cochran-Smith, 1992).

The purpose of this study was to investigate teacher PD through CoPs that focused on assessment practices, an area that currently lacks research that connects this practice to professional knowledge. In particular, we explored the factors that influence PD in the educational context of South Korea. This study is a natural approach to examining CoPs (Wang et al., 2002) that had already been established in one middle school in South Korea.

LITERATURE REVIEW

Communities of Practice

The concept of the CoP was developed to account for the social nature of human learning (Wenger, 2000). A CoP provides opportunities for members to develop professional knowledge. Members of a CoP can progress from novices to experts through their involvement in the community (Correa, Martínez-Arbelaiz, & Aberasturi-Apraiz, 2015). They work collectively on key tasks, and their proficiency levels increase over time. The members rely on support and feedback from the community and share ideas through discussion and dialogue (Correa et al., 2015). The community can be seen as a simple social system; this complex social system can be interpreted as the interaction of simpler social systems. This is similar to understanding a mixture of complex properties as the interaction of simple elements and compounds.

The CoP should be understood as a conceptual framework for learning at the social level and can be found in the relationship between people and society. In this relationship, the individual and society act as constitutive factors. In order for meaningful learning to occur in a social context, the interaction of two factors, participation and reification, are essential (Wenger, 2000). Wenger (1998) argued that all communities are diverse because they all have their own unique practices; however, all communities have common attributes. Wenger (1998) stated that the common attributes of the CoP are mutual engagement, joint enterprise, and shared repertoire (Akerson et al., 2009; Fultak & Heredia, 2014; Jones et al., 2015). According to Wenger (1998), mutual engagement refers to participation based on cooperative relationships among various members, while joint enterprise refers to shared responsibility with other members, and shared repertoire refers to the artifacts and discourse produced by the members through community activities.

Over the past 30 years, many international studies have focused on the importance of teacher learning communities (Akerson et al., 2009; Daniel et al., 2013; Dobie & Anderson, 2015; Gao & Wang, 2014; Johnston & Settlage, 2008; So, 2013). In a school setting, CoPs are naturally and intentionally organized among teachers. They

focus of collaborative planning of lessons and study units, assessment, improving teaching practices, as well as coaching and mentoring, processes which are inherently collaborative. van Driel and Beijaard (2003) reported on experience-based interaction, which can be described as the sharing of ideas related to teaching practices. Teachers discuss ideas with their colleagues and listen and respond to each other. Importantly, in this environment, teachers can be inspired by and learn from colleagues when interactively sharing ideas.

In CoPs, teachers develop mutual trust, which is the basis for explorative and reflective thinking on relevant issues. It also builds a foundation for establishing common values and setting goals, promotes collective responsibility for student learning, increases reflective professional inquiry, promotes collaboration, and incorporates collaborative learning as well as personal learning (Jones et al., 2013; Nickerson & Moriarty, 2005; Stoll et al., 2006). Therefore, CoPs not only strengthen the professional community but are important for effective PD (Thomas et al., 1998; van Es, 2012; Vescio, Ross, & Adams, 2008). Specifically, CoPs can work more efficiently when the following elements are satisfied: (1) there are shared norms and values, (2) there is a focus on student learning, (3) there is reflective dialogue among teachers, (4) there is a sharing of practice through public discussions on instructional cases and problems among colleagues, and (5) there is collaboration regarding curriculum and instruction (Schweingruber, Duschl, & Shouse, 2007; Stoll et al., 2006).

Teachers' professional development can be promoted through CoPs as well as through individual practice, since teachers in CoPs can become autonomous experts, rather than simply passive knowledge deliverers (Sato, Akita, & Iwakawa, 1993). Cochran-Smith and Lytle (1999) suggested three types of knowledge related to practice: *knowledge-of-practice,* which is constructed within teacher CoPs; *knowledge-for-practice*, which is produced by researchers; and *knowledge-in-practice*, which is developed through competent and experienced teachers' practice. The knowledge relating to teacher CoPs represents knowledge-of-practice, which teachers construct through practice. That is, teachers can be active constructors of knowledge, rather than simply passively receiving it from an outside source (Lytle & Cochran-Smith, 1992).

All professional development programs have value when teachers are provided with new opportunities (Garet et al., 2001). Therefore, studies of teacher PD that focus on teacher learning communities require a higher level of participation than merely joining in CoP activities (Grossman et al., 2001; Jones et al., 2013). However, when teachers collaborate with their colleagues to achieve common goals, occasionally the relationship between them can become tense because of conflicting individual beliefs on teaching practice (Dooner, Mandzuk, & Clifton, 2008; Glackin, 2016; So, 2013).

Teledahl (2015) reported that teachers can arrive at different evaluations of the same students' work because they have different content knowledge. In Teledahl's study, when assessing students' work, teachers looked for content knowledge gaps in their understanding of science concepts. However, different evaluations of the same students' work came from interactions between factors such as the teachers' beliefs and previous experience (Gao & Wang, 2014). Therefore, professional discussion on the different ways in which teachers assess student work is key to confirming the quality of assessment (Clarke, 1996), since different grading evaluations stem from differences in interpretation, not from a difference in standards (Morgan & Watson, 2002). Therefore, teachers' professional knowledge of assessment might be influenced by CoPs, as they can reveal these differences of interpretation and encourage cooperation and reflection on assessment practices.

Grossman et al. (2001) reported that the expression of opposing opinions within CoPs could strengthen the community. In their study, teachers initially ignored conflicting opinions, but gradually began to acknowledge diverse opinions, and eventually considered all the various discussion points offered in the group. This reflects how critical discussion can be key to developing teacher CoPs (van Es, 2012). Dobie and Anderson (2015) found that expressing an opposing opinion could improve the quality of collaboration and decision-making within a community. Thus, by contributing to critical discussions with colleagues, teachers can potentially modify their beliefs and improve their professional practices (Achinstein, 2002; Grossman et al., 2001; Mitchell, 2015).

Mertler (2009) indicated that previous studies relating to assessment knowledge and practice had focused on identifying what teachers do not know, on what teachers do know, and on which methods individual teachers use to assess student work. After marking, the teachers discussed their methods with the researcher and other

participants in a workshop and determined best practice methods. Specifically, when students answer open-response questions, in contrast to multiple-choice questions, teachers can improve their knowledge of their students' understanding through the assessment process (Mertler, 2009). Teachers can construct new knowledge through this experience, which in turn affects their practice (So, 2013). Such reflective thinking comprises a "purposeful, deliberate act of inquiry into one's thoughts and actions" (Loughran, 1996) and therefore improves teaching practice.

Teachers should continue to improve their practice by regularly using the reflection process: *reflection-in-action* is the process of reflection during practice, *reflection-on-action* is the process of reflection after practice, and *reflection-for-action* is the process of reflection on practice whereby teachers reflect on their past actions and plan for future actions accordingly (Schön, 1983). Reflection serves as a starting point for teachers to examine and evaluate their professional knowledge and beliefs (So, 2013). For this reason, teachers' reflective practices are essential for professional growth and learning (Schön, 1983). If we promote autonomous reflective thinking during teaching practice, teacher PD can be accelerated.

Individual teacher growth is less effective with independent reflective practices in terms of practical knowledge for effective teaching (Schön, 1983). However, this could be improved with colleague interaction (van Driel, 2010), because teachers within a community can exchange individual reflections based on their own experiences (Pintrich, Marx, & Boyle, 1993; So, 2013; Tillema, 1997). Therefore, teachers should be given the opportunity to reflect on different perspectives within CoPs that they may not have been exposed to otherwise (Mitchell, 2015).

This study differs from existing research in that the teachers' communities were already in place prior to the study and were voluntarily established among the teachers themselves. In the case of voluntary CoPs, it is likely that conflict will not become serious because it is not necessary to reach consensus. However, as in the case of student assessment, if the teachers need to agree on student scoring standards, the communities will likely encounter conflicts among the teachers. Research on how teachers collaborate to overcome conflict and develop their professional knowledge is crucial. In the study of Jones et al. (2013), the greatest change observed in teachers' professional knowledge in the CoP was regarding science assessment strategies. Therefore, in the present study, the distinct feature of teacher's PD in CoPs for student assessment was observed.

PURPOSE OF THE PRESENT STUDY

The purpose of the present study is to explore the interactions of teachers in CoPs and identify the factors that develop or inhibit the development of teachers' professional knowledge. In the present study, the interactions among teachers were divided into three types: the process of developing assessment items, the process of implementing assessment, and the process of feedback. The research questions of this study are as follows:

1) What are the characteristics of the teacher interaction in the two teacher communities at the stage of developing the assessment items?

2) What are the characteristics of the teacher interactions in the two teacher communities at the stage of implementing the assessment?

3) What are the characteristics of the teacher interaction in the two teacher communities at the feedback stage after assessment?

In this study, we investigated the obstacles and support for teacher's PD within the CoPs. In particular, we wanted to explore the teachers' complex social relationships (Erickson, 1986; Lave & Wenger, 1991; Lewis et al., 2015). Since all teachers' PD experiences are unique (Lewis et al., 2015), it will be difficult to draw general conclusions from this study. However, it is useful to have an understanding of how a teacher's PD is actively applied, implemented, or rejected in a CoP.

Table 1. The Three Dimensions and Properties of a CoP

Dimensions of CoP	Properties of CoP
Mutual engagement	• Members of other backgrounds (involvement of different subject teachers, full-time and part-time teachers) participate in the development of common assessment items and assessment criteria, and common evaluation activities. • At least one year of continuous involvement is maintained for evaluation activities with complex relationships with guidance students, parents, school administrators, local education offices, and the Department of Education.
Joint enterprise	• Members have a collective responsibility for assessing students. • Evaluation activities are conducted through continuous negotiation among the teachers in the community.
Shared repertoire	• Curriculum resources and policies related to assessment are developed by the members. • Data and events related to the evaluation and the evaluation criteria can be modified by the members.

METHOD

Research Design

For the purposes of the present study, we analyzed the classroom activities of each teacher and their collaboration and reflection processes for student assessment within their CoP. Similar methods of research design to several existing studies (Cochran-Smith & Lytle, 1993; Hashweh, 2005; Magnusson et al., 1999; Friedrichsen et al., 2009; Park & Chin, 2011; Veal, 2004; Gess-Newsome et al., 2011; Lewis, 2011; Park et al., 2007; van Driel, 2010) were used in this study.

Based on Wilson (2013), who identified five main characteristics of an effective PD program, we focused on the following five aspects in the present study: (1) the specific content of the assessment item, (2) the active participation of teachers in the CoP, (3) the collective participation of teachers in the assessment process, (4) the procedures through which student achievement of Ministry of Education learning targets could be measured, and (5) the use of a one-semester or longer observation.

The observation of interactions in the teacher CoPs was divided into three stages. The first stage consisted of the development of the assessment items and rubrics. The second stage consisted of the elaboration of the assessment tools developed–this was where assessment practice, reflection, and cooperation occurred most actively. The final stage consisted of the return of teachers to their classrooms provide feedback of the assessment results to the students. This last stage allowed us to identify the individual teacher's perceptions of the interactions that had occurred within the CoP.

Since the community designed in this study had three dimensions, it was considered to possess the characteristics of a CoP as proposed by Wenger (1998). The concrete contents are shown in **Table 1**.

Context and Participants

Public schools in South Korea face intense pressure to improve student achievement, so there is a significant demand for effective teacher PD. All schools in South Korea are required to follow the standard national curriculum that is revised periodically. Although various textbooks are developed and used, all textbooks are part of the national curriculum to ensure consistency in the contents at each grade level.

Most middle schools in South Korea conduct regular assessments twice a semester. These assessments comprise the students' summative evaluations and are used as base data for entrance to high school. Because of their importance, most students and parents are very sensitive to test scores. The fairness of the assessment criteria

Table 2. Participant Characteristics

Community	**Community 1 (Grade 7)**		**Community 2 (Grade 9)**	
Characteristics	**Teacher A**	**Teacher B**	**Teacher C**	**Teacher D**
Gender	male	female	male	female
Age	late 30s	early 40s	early 50s	early 40s
Major	physics	physics	physics	earth science
Years of experience	7 years	9 years	25 years	14 years

and the clarity of the scoring results are of great concern to teachers. Teachers put forth a lot of effort to avoid receiving complaints from students and parents about overly subjective test results. When there is a significant difference in class average according to the teacher, they receive negative feedback from administrators, parents, and students. That is why the teachers collaborate with their colleagues in a CoP to develop assessment items and determine scoring. This collaboration among teachers in CoPs is thus important in establishing teachers' identities. In most schools, a teacher does not develop student assessment items independently, but all teachers of the same grade work together. The Ministry of Education in South Korea implemented a policy to increase the number of open-ended assessment items to measure the in-depth knowledge of students. During the process of scoring students' answers to open-ended test items, active cooperation occurs among teachers in a CoP to ensure that the wide variety of student responses that can occur are graded consistently. Therefore, this study collected data on teacher interactions in CoPs regarding the development and scoring of open-ended assessment items.

The school selected as the site of this research consists of 28 classes from seventh to ninth grade. The school is located in the outskirts of Seoul, South Korea. According to the results of the National Achievement Test conducted at the time of the study, 52% of all students at the school were within the average range and 11.6% were within the low academic achievement range. This means that the level of student achievement at the school is close to the national average.

There was a total of six science teachers at the school; four of them participated in this study. Teachers A and B, who teach seventh grade science, comprised Community 1, while teachers C and D, who teach ninth grade science, comprised Community 2. Teacher B also taught some subjects in 9th grade, but she acted as an advisor to Community 2 rather than a participant because she had to participate in Community 1. The characteristics of the teachers who participated in this study are displayed in **Table 2**.

Data Sources

In this study, we obtained various data through continuous participant observation and analysis (Spradley, 1980) to investigate the social communication processes within the teacher CoPs. After obtaining permission from all participants, we installed recording devices on the discussion tables to record discussion in the CoPs, which took as long as one week per exam.

We obtained meaningful data from the focal situations (Merriam, 1988) before consensus was reached in the CoPs. In such cases, the teachers had difficulty communicating, and engaged in active discussion to come to a consensus regarding the evaluation of open-ended test questions. After reaching an agreement on the scoring criteria, the teachers individually scored the students' tests. After grading the tests, the CoPs met again to restart discussions regarding student test responses where necessary, until consensus was reached again. Then, rubrics were revised and the scoring of exams was corrected as needed.

We obtained data from the midterm and final exams during the first semester and from the teachers' CoP activities related to these assessments. We also obtained data from the observation of the CoP teachers' classroom activities, as well as individual interviews to aid in the interpretation of the data.

In total, we recorded 170-185 minutes of discussion from each CoP. Community 1's discussions consisted of a lot of debate due to the teachers' different beliefs and knowledge backgrounds. Community 2 worked more

often than Community 1 at the request of Teacher D, who wanted to reach consensus on student scoring criteria. However, the lack of conflict may be attributable to Teacher C's desire to avoid confrontation with Teacher D. Video data from 10-15 lessons per teacher were collected because teachers' responses in the CoP were related to their teaching strategies and their personal understanding of students in their classes. For this, the first author of this study installed video cameras in the back of the classrooms, and she remained in the classrooms during the recorded lessons to take field notes.

To acquire additional information from the participants, three formal interviews were conducted with each of the four teachers and informal interviews were conducted before and after teaching and during the grading of the students' exams. The first interview was conducted at the beginning of this study to assess the teachers' professional knowledge of developing assessment items. The second interview was conducted in the middle of this study to identify the characteristics of interactions among teachers in the CoP during the implementation of the assessment. The third interview was conducted after scoring the students' exams to study the teachers' relationship within the CoPs. We observed the classes taught by each of the four CoP teachers, and these data were used as supplementary materials for interpreting the teacher's activities and behavior in the CoP.

Five or six open-ended questions were produced for each exam by the teachers, and the CoP actively worked to agree on the scoring criteria to fairly evaluate the students' responses to them. Although open-ended questions are difficult to score compared to multiple-choice questions, they were introduced into the Korean national curriculum to measure students' higher-order thinking skills. However, in most cases, the average score for the open-ended questions requiring higher-order thinking skills was higher than the average score for the multiple-choice questions requiring simple knowledge recall. This means that the scoring criteria of the open-ended questions agreed to by the teachers failed to adequately measure the students' higher-order thinking skills. We analyzed and diagnosed the causes for this phenomenon based on the teachers' interactions in the CoP.

Data Analysis

The data were collected from the discourse within the CoPs, participant interviews, observation notes from the CoPs, assessment item data, and the scoring criteria generated within the CoPs. We compared the data using a triangulation method to gain a better understanding of the teachers' activities in the CoP.

In general, the cooperation and reflection of the teachers in the CoPs differed in each of the three stages: the development stage of the assessment items (Process D), the implementation stage of the assessment (Process I), and the feedback stage after the assessment of the students' exams (Process F). Therefore, we analyzed the data separately for each of the three stages.

Teachers' interactions within the CoPs were coded into six types: reflection, conflict within collaboration, conflict resolution, continued conflict, identification, and learning partnership. We attempted to identify data by the codes individually, and reach a consensus on the patterns involved in the interaction. We explored the factors that could explain the teacher's activities within the CoP through their arguments in the scoring process, as well as through additional data obtained through individual interviews. In similar cases, we coded data by applying common patterns. In particular, when it was difficult to identify the factors in a teacher's decision-making process, the data was reanalyzed and recoded until a more general meaning was found to understand individual cases. Using constant comparative analysis (Miles & Huberman, 1994), we identified the characteristics of the teachers' assessment practices and arrived at a concerted conclusion.

The coding was focused on finding factors that influenced the teachers' interactions in the assessment process. In other words, we tried to find the areas where PD influenced the CoP by analyzing the relationships of the coding data related to the interactions between the teachers. **Table 3** shows the meaning of each code and examples.

Table 3. Coding Categories and Examples

Category	Description Example
Collaboration	Teachers make a shared repertoire in a CoP.
	Teachers conduct activities that determine the scope of the assessment, design test items, and cross-examine them with a colleague in the CoP.
Reflection	Teachers reflect on the assessment items they made in the CoP
	Teachers reflect on their own activities when they realize a scoring criterion was wrong.
Conflict	Conflict can occur due to differences in teachers' beliefs and knowledge in a CoP.
	Conflicts can arise when the teachers have different understandings of the curriculum, such as the importance of the calculation process or writing units, as well as differences in opinions regarding the weighting questions or the scoring criteria.
Resolution	Teachers suggest a solution to their colleagues to solve conflicts or problems encountered in the CoP.
	Teacher B changed her opinion on the scoring criteria by considering her colleague's point of view.
Continuing conflict	Teachers' suggestions do not contribute to the resolution of the problem encountered in the CoP.
	Even though they agreed in the CoP, they continued to complain about the outcome of the agreement.
Identification	Recognizing problems that occur in the CoP as their own problems.
	When the correct answer rate was low on the items made by Teacher A, Teacher B felt responsible because she did not cross check the questions.
Learning partnership	Teachers' professional knowledge is developed by forming partnerships with colleagues in the CoP.
	Teacher A helped Teacher B with the answer to a question that she could not solve.

RESULTS

Interaction in the CoPs in the Stage of Developing Assessment Items (Process D)

Reflection. In the process of developing open-ended assessment questions, the factor that the teachers considered most was the ease of scoring. Open-ended questions should evaluate students' thinking in greater depth than multiple-choice questions, so assessing different student responses was burdensome for the teachers. However, in order for teachers to develop their PD and assessment knowledge, they must establish valid evaluation criteria and evaluate students' work accordingly. However, most teachers in the study displayed resistance to PD by making the open-ended questions easy for scoring, which could not contribute to their professional growth. The following discussion was recorded in Community 1, which consisted of Teachers A and B, while cross-examining the open-ended test items.

Teacher B: Most of the items are difficult.

Teacher A: I am also reviewing the difficult items.

Teacher B: Did you not review the open-ended items?

Teacher A: Not yet. I made it long and difficult because the score of the item is 10 points. It will be difficult because the students have to write long answers. I divided the items into several sub-scores to make it easier for us to score. It's easy to score.

(Community 1 on September 19, 2011)

The following discussion was recorded in Community 2:

Teacher C: I can finish scoring it tomorrow morning.

Teacher D: It is not hard to score the open-ended items.

Researcher: Good!

Teacher C: But when we make the open-ended items this way, the administrator notices.

Researcher: I think Teacher D changed her usual style of open-ended item form.

Teacher C: It is a simple change.

Researcher: Was scoring the last open-ended item too difficult?

Teacher C: My head was hurting. After scoring the answers of one class, my head was hurting too much.

Researcher: Last time, you talked to teacher D a lot in the community.

Teacher D: It's because the item was too open. The open-ended item was too difficult to score. It was too open at that time.

(Community 2 on September 28, 2011)

The intention of the open-ended assessment was to invite diverse responses from the students. However, the teachers had a difficult time scoring unexpected answers. They resolved this problem by changing the item type to restrict the potential for diverse responses. This was successful in terms of improving the ease of scoring from the teachers' viewpoint, and strengthened the consensus to enable simpler scoring for the next assessment. The teachers' experience of past exams seemed to be a hindrance of teacher PD.

The teachers were aware that their practice was inadequate to measure student achievement on open-ended questions made in accordance with the Ministry of Education's guidelines. Thus, Teacher C mentioned that it was a good idea to obtain the administration's approval of the open-ended questions they had made. However, they had already learned about the effort required to score complex responses. It is difficult to expect a certain outcome in a situation where the teachers have different professional backgrounds or the administrative policies and guidelines are unclear or restrictive.

In contrast to the intention to make scoring easier, Teacher A realized during the interview with the researcher that it was difficult to make scoring criteria in Process D. This was due to Teacher A's lack of professional knowledge of assessment, and he did not consider the students' diverse responses or the curriculum targets when he created the open-ended questions. The following statement by Teacher A was recorded in an interview with the researcher:

Teacher A: Actually, I made this item because I did not want to make a 10-point item carefully. If I suggested 2 or 3 keywords to the students for an answer to a 10-point item, it was a problem because the score for one keyword was too high. So I wrote the item so that students would write a long answer, but that made it difficult to score. It would have been nice if I had created sub-items for the 10-point item. Now it's too difficult to make scoring criteria. I am not sure how could I change the scoring criteria since the combination of words is too complex.

(Interview with Teacher A on September 28, 2011)

Considering the convenience of scoring rather than the curriculum or the students' understanding indicates a low level of professional knowledge. He did not realize that the intention of open-ended evaluation is to access the students' higher-order thinking, even though he made the open-ended items in accordance with the Ministry of Education policy. Therefore, although Teacher A produced a certain percentage of open-ended questions in accordance with the policy, he thought that the assessment items were troublesome and required too much effort to score. The following conversation between Teacher A and B was recorded during a CoP meeting:

Teacher A: If the students' answers are not what we wanted, we should decide that they are definitely wrong.

Teacher B: You should have put the word "concentration" as one of the keywords, but it was not suggested in the question.

Teacher A: (Loudly) I should have put the word "concentration" at the right time when I realized the problem, but I neglected to fix the item because I had to change the space for the answer again. So I just left it.

Teacher B: Why would you need to change the space for the answer to add the keyword "concentration?"

Teacher A: You have to increase your scoring chart to five if you add keywords. Because Teacher B did not say anything, I did not fix it because I was irritated.

Teacher B: I did not review the scoring criteria.

Teacher A: When I first thought of "concentration," I should have fixed the item by putting it in.

(Community 1 on September 28, 2011)

In general, during Process D, the teachers' interactions within the CoP were superficial. Although the teacher who created the item found the error on his own, he decided to ignore the problem when his fellow teacher did not recognize it. The teacher's attitude related to writing the test items and scoring them would eventually lead to a waste of time by lowering the criteria of the open-ended items for measuring the students' higher-order thinking. Generally, during Process D, the teachers' interactions within the CoPs were mainly influenced by past experience, and focused on the ease of scoring the test items. Therefore, the depth of their reflection was superficial.

Conflicts within collaboration. In Process D, although the two CoPs displayed similar patterns of reflective thinking, they showed different patterns of cooperation. In Community 1, deep interactions were often observed in Process D, and conflicts appeared on the surface of interaction. Within the community, interaction was initiated by Teacher B, who recognized the problems in the test items. The following conversation was recorded during a CoP meeting:

Teacher B: Item 5. Are the students doing well? Should we put in the item statement that 1kg of gravity is 9.8? Because some of the students may calculate it with different values, such as 10 instead of 9.8.

Teacher A: Do not put 9.8. The contents are in the textbook. For the students, I will emphasize it in class next time. When we teach it, we should not say that we can consider 1 kilogram of gravity as 10N.

Teacher B: Right? I still have time to teach it. And these two items are similar to the questions that you wrote last year.

Teacher A: I remember.

Teacher B: Do students remember last year's items and raise objections?

Teacher A: This item is completely different than last year's items. You are too timid.

Teacher B: I agree. You know how to solve this item?

Teacher A: You will know when you read the items. In fact, it might be difficult for some students.

Teacher B: So I put the word "buoyancy" in the scoring criteria for those students who cannot do the calculations. But you omitted the word in the criteria.

Teacher A: The item seemed too complicated so I changed it. The rest is the same.

Teacher B: The students will find it hard to figure out.

(Community 1 on September 19, 2011)

In Community 1, the teachers' conflicts are related by Teacher A, who considered the importance of the curriculum in the assessment items, and Teacher B, who took account of the students' abilities. Teacher A had greater professional understanding of curriculum planning and Teacher B had a greater professional awareness of the students.

Teacher A and Teacher B conflicted in Community 1, but the conflict was solved by providing a teaching strategy suggested by Teacher A. Therefore, the students' ability level required to answer the items correctly remained high.

However, in Community 2, the same level of cooperation between the two teachers was not often observed. In Community 2, Teacher D recognized most of the problems, as Teacher B did in Community 1. On this matter, Teacher D stated the following in an interview:

Teacher D: Oh! The students have difficulty with the law of conservation of mass and the law of constant composition ratio. I taught it well, but did the students understand it? This is a calculation problem, why can't the students solve the calculation problem? I am afraid that the students who learned from me will not be able to solve the problems written by Teacher C.

(Interview with Teacher D on September 19, 2011)

In a similar situation to Community 1, Teacher A rejected Teacher B's proposal and suggested a consensus on improving the students' understanding through instructional strategies during class. In the process, the conflicts between the teachers were revealed, and as a result, the difficulty level of the item was retained. However, in Community 2, Teacher C did not respond to Teacher D's proposal; thus, conflicts were not exposed on the surface. As a result, Teacher D made the items developed by Teacher C easier for her students to answer. Teacher D expressed the cause of his behavior to the researcher as follows:

Researcher: Are there any items that were revised while reviewing the items together?

Teacher D: Teacher C did not discuss many of the items I had made. And if I saw items written by Teacher C that I did not teach to my students, I removed them. Teacher C did not get involved if I deleted or modified any items at will. In fact, teachers often teach what they do not know, and if that is the case, then we have to mark all kinds of students' answers as correct. So I examined the items very well. Because I was worried about the items written by Teacher C that I had not taught, I edited them.

(Interview with Teacher D on September 19, 2011)

The poor communication between the two teachers in Community 2 seemed to be because of a lack of respect between them. Teacher D did not trust the items that Teacher C had written, and judged Teacher C's professional knowledge related to the contents to be low. She expressed this by saying, "Teachers often teach what they do not know." Teacher C was aware of Teacher D's attitude, and did not interfere with her in order to avoid conflict. Therefore, in Community 2, it was hard to observe any conflictual interactions between the two teachers. On the surface, they appeared to work well together and cooperate with each other.

Interaction in the CoPs in the Stage of Implementing Assessment (Process I)

Conflict resolution within collaboration. Sometimes, the conflicts between Teacher A and Teacher B in Community 1 revealed during Process D were serious and they did not reach consensus easily. However, during Process I, when problems occurred from the conflicts, the two teachers worked together to resolve them. The following conversation was recorded in Community 1:

Teacher B: Because the word "concentration" is really important for the answer to this item, an answer without this word is wrong.

Teacher A: But this student has written everything that the question demanded. By the way, if you look at this answer, the student should have received a score higher than 8 out of 10 points. Teacher B: There are no really important words that must appear in this answer because we did not suggest any words in the question. So we should score the answer...

Teacher A: So according to the scoring rubric, the score of this answer is 8 points.

Teacher B: I'll score it as 8 points. I cannot find a better solution.

(Community 2 on September 28, 2011)

The characteristics of these collaborations included agreeing with assessment criteria that were lower than the scoring criteria established in Process D. This means that more students are getting higher marks, which is how Teacher A persuaded Teacher B to agree. In this context, it was more important for the teachers to consider their colleague than the impact of the evaluation on students. For example:

Teacher B: I marked this as a wrong answer.

Teacher A: Really? I thought it was a calculation process when students wrote this. So let's mark this answer as correct. Many of our students scored low on it.

(Community 1 on October 4, 2011)

Teacher A claimed higher assessment criteria in Process D, but changed his attitude in Process I because the rate of correct answers was lower than expected. In process I, Teacher A showed a similar attitude as Teacher B by insisting on lowering the scoring criteria for students. To gain a greater understanding of the teachers' feelings regarding consensus in Community 1, the researcher conducted interviews. As a result, it was confirmed that the health of the partnership was maintained by considering the position of the colleague after encountering conflict. Teacher A revealed the following opinion during an interview:

Researcher: Since the scoring criteria have changed, should you mark the students' answers again?

Teacher A: I was scoring certain answers as correct, but Teacher B was scoring them as wrong. So I talked with her to consider the situation differently. But Teacher B would not change her mind and said that I was wrong. But I did not agree with her. So I was angry and shouted, "So I am wrong."

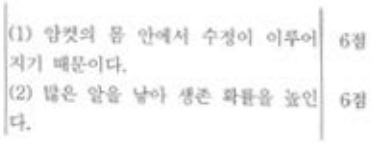
Researcher: You expressed your opinion very strongly.

Teacher A: I did not express myself in a pleasant way. So Teacher B said she was sorry and agreed that the answer was correct. I felt so disgusted because I was too assertive. Finally, we considered each other's positions.

(Interview with Teacher A on October 4, 2011)

In Process I, Teacher A tried to reach consensus in the discussion with Teacher B by being overly assertive and making an effort to share his knowledge with Teacher B. Teacher A shared his reasons for this behavior in an interview with the researcher:

Initial scoring rubric made in Process D



Modified scoring rubric made in Process I

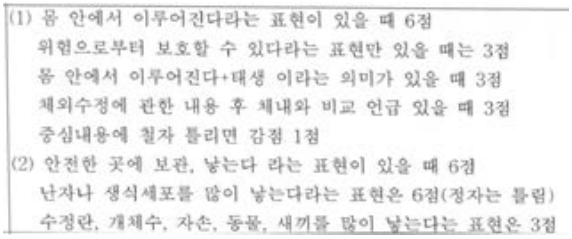


Figure 1. An example of initial and modified scoring rubrics in Community 2

Researcher: In general, answers with the wrong calculation processes are marked wrong, as Teacher B stated. Why did you insist on marking it correct?

Teacher A: Students may make the wrong calculations. This particular item does not require the students' calculation ability. As a matter of fact, I have participated in grading online assessments of academic achievement during summer vacation. At that time, the scoring criteria did not merely consist of calculating ability, but more importantly of judging whether the students knew what they really needed to do in this problem. I wanted to explain that to Teacher B.

(Interview with Teacher A on September 29, 2011)

The result of Community 2's agreement was similar to that of Community 1 by lowering the scoring criteria. In Process D, the criterion of the correct answer was very high and there was no consideration of partial scores, but the rubric of scoring which the teachers agreed to in Community 2 in Process I lowered the standard for a perfect score and increased partial scores. This also means that cooperation between teachers occurred so that more students received better grades.

Figure 1 shows an example of the scoring rubrics made in Process D and Process I in Community 2. In Process I, the expected responses were very simple and the scoring criteria were high. However, after the assessment of Process I, students were given partial scores for their responses and various answers were marked as correct.

Reflection and cooperation for raising students' correct answer rates to solve problems due to the lack of teachers' professional knowledge about students were frequently observed. When multidimensional problems that stemmed from a lack professional knowledge, such as an understanding of the students or teaching and assessment strategies, were revealed in the CoP, teachers tried lowering the scoring criteria to solve the problems. This can be interpreted as a decision made out of the consideration for colleague teachers in order to avoid revealing their lack of professional knowledge.

Lasting conflict within collaboration. In Community 2, Teacher D did not respect Teacher C, as it was revealed during Process D. Teacher D responded aggressively to Teacher C's suggestion of lowering the scoring criterion by saying, "Did you ever it teach in reverse?," which caused difficulties in their working partnership and impeded interaction. The following conversation was recording in Community 2:

Teacher D: Then just give a full score to answers with circles on top of the stationary front. The upper side should be round and the bottom side should be spiky because this is the condition of Korea.

Teacher C: These students drew it the opposite way.

Examples of students' answers

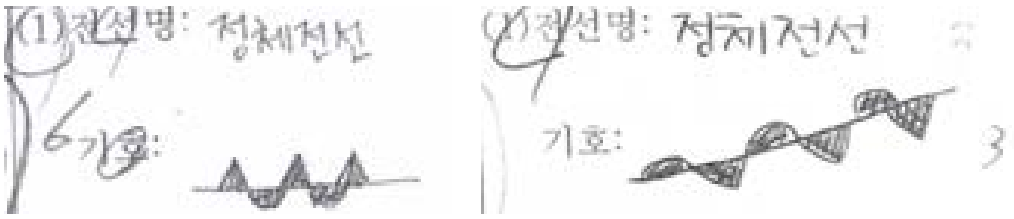


Figure 2. Two student answers that created conflict between Teacher C and Teacher D

Teacher D: Really. Korea has a warm front on the bottom side and a cold front on the top. Did you ever teach it in reverse? (Laughing)

Teacher C: I did not teach it like that. It's in the book. I simply taught that the round shape is the warm front, and the sharper one is the cold front.

Teacher D: Then, what should we do with the student answers? There are all types of answers, such as uncolored ones or ones with deviant crease lines, or backwards ones. Should we mark them all as correct answers?

Teacher C: Score all the answers as correct answers. I do not like it, either. But let's do it.

Teacher D: OK.

(Community 2 on September 29, 2011)

Figure 2 shows a comparison of student responses that conflicted with the scoring criteria of Community 2. The one on the left is an answer that Teacher D had judged to be correct, and the one on the right is an answer that Teacher C insisted on giving full marks to.

However, consensus was reached after the conflict because power was conceded to Teacher C, even though Teacher D did not internalize the consensus. The reason for this is that Teacher D doubted the professional content knowledge of Teacher C on this test item. The question was related to earth science, which Teacher D had majored in, but Teacher C had majored in physics. Another reason why Teacher D did not agree internally was that she expected student complaints due to the way Teacher C had taught the concept in class. Teacher D stated the following in an interview:

Teacher D: I agreed with Teacher C that answers showing opposite directions were correct, but I taught the concept using a map of Korea in my class and explained that the direction was important using the analogy of "What happens when North Koreans and South Koreans fight with each other? Of course, South Korea wins." This analogy teaches the students that the cold front of the upper direction means north and the warm front of the lower direction means south. So if they draw the figure using the opposite directions (on a map of Korea), it's wrong.

(Interview with Teacher D on October 7, 2011)

Teacher C was also aware of Teacher D's criticism, and the difference in their majors made the situation of determining the scoring criteria more sensitive. Teacher C stated the following:

Teacher C: I taught my students without thinking about it at all. Teacher D majored in earth science, so I know that she is more knowledgeable then me on the subject. In this respect, there are differences between major and non-major teachers. I've taught students using this method so far, but I have never thought about the direction. I did not see this information in the teacher's guidebook.

(Interview with Teacher C on October 5, 2011)

Initially, we judged that Teacher D had a better understanding of content related to the assessment items, but after the interview with Teacher C, we ascertained that he had a more complex understanding of curriculum planning. The claim of Teacher D that the right picture in **Figure 2** was correct is in the precondition of Korea map. But as explained in Teacher C's comment, there was no Korean map included in the instructions for that test item.

However, because his major was not earth science, Teacher C did not interact with Teacher D in a positive discussion. Teacher C suggested that he had taught the concept differently in his classes and so the scoring criteria might need to be changed. The power in Community 2 shifted to Teacher C, but he did not know how to effectively resolve conflict in the community. He suggested a superficial level of consensus because he was not trained to deal with complicated human relations issues.

In sum, consideration for colleague teachers was the reason for consensus in Community 2, which Teacher C suggested to Teacher D. If only the answer on the left in **Figure 2** was marked as correct as insisted by Teacher D, which would have placed Teacher C in a difficult position because of the opposition he would have received from his students. Thus, the most important factor in the interactions of Process I was the consideration of colleague teachers rather than the actual learning of the students.

Interaction in the CoPs in the Stage of Feedback (Process F)

Identification. Different types of interactions were observed between the two CoPs in Process F. The most obvious difference was the identification of problems. Although there were conflicts between the teachers in Process D and Process I, after coming to an agreement, the identification of a problem in scoring criteria that was their own responsibility was often observed in Process F for Community 1. Teacher A commented as follows:

> Teacher A: The students did not get so many wrong answers on past exams, but I left a mark in my teacher life. I just noticed that the scoring rubric is wrong, too. I did not think that the problem was the scoring rubric at first. But when I saw the students' answers, I noticed my mistake. It's a mess, so many students came and asked "Teacher, is this the answer or not?" I hated scoring it. I could not score it any more.
>
> (Interview with Teacher A on September 29, 2011)

Teacher A insisted on keeping the level of difficulty high during Process D. However, after encountering the low rate of correct answers, Teacher A reflected on his professional knowledge related to assessment, as follows:

> Teacher A: It's all my fault.
>
> Researcher: Why do you think it is your responsibility?
>
> Teacher A: Because I made the items difficult, and I did not think it was difficult when Teacher B insisted on it. But the kids felt that it was hard. I was wrong when I made the assessment items, or I was wrong when I taught the students. The problem is one of those.
>
> (Interview with Teacher A on December 15, 2011)

The willingness to accept responsibility for one's mistakes is also an aspect of professional growth. Teacher B, who agreed with Teacher A's concerns, accepted joint responsibility for the situation. She felt guilty for not having prevented this problem in the CoP. This can be seen as evidence of teacher identification with the CoP. On this matter, Teacher B stated the following:

> Teacher B: Too many students got this question wrong. I should have examined it properly when you gave it to me, but I did not know there was a problem.
>
> Researcher: You talked a lot with Teacher A when you edited the assessment items?
>
> Teacher B: I have to examine the items with the scoring rubrics together. But I did not because I was short on time. So both Teacher A and I made a mistake.

(Interview with Teacher B on September 29, 2011)

Although Teacher A made the initial decision about the item, Teacher B also took responsibility for the mistake. Therefor we decided that Teacher B identified the decision in the community. In Community 1, the identification within reflection was continuously observed during Process F. During Process F in Community 1, the teachers recognized the differences in students' understanding between teaching and assessment phases. Through the scoring process, the teachers were able to improve their understanding of student learning and received an important opportunity to reflect on their teaching goals and strategies. The teachers had related the error to their lack of professional knowledge. However, this kind of experience, if coupled with effective reflection, can have a positive impact on teacher PD.

On the other hand, Teacher D, who was dissatisfied with the consensus in Community 2, had often been seen expressing her frustration to the students in her class. This reaction means that identification with the community was not formed. The following conversation was recorded during a class observation:

Teacher D: This problem is easy. The stationary front stays in one place because the forces of the two fronts are similar. The correct answer is that there is a warming front in the south, and a cold front in the north. But there are many students who drew it differently.

Student 1: That's what I drew.

Teacher D: That's why I scored it as the correct answer.

Students: Wow!

Teacher D: I marked the figures without coloring as correct.

Student 2: Oh, no!

Teacher D: I was upset when I marked these answers as correct. Can you imagine who insisted on these scoring criteria?

Students: Teacher C?

Teacher D: Anyway, you understand the meaning.

Student 2: Oh, no. Really!

Student 3: You should score that answer as wrong.

Teacher D: That's why I'm so upset. There will be about 10 students per class who achieved a full score with wrong answers.

Students: It was too easy.

(Teacher D's classroom observation on October 4, 2011)

In this situation, Teacher D thought that her judgement was correct regarding the items related to earth science because her major was earth science. However, she did not draw a map of Korea or suggest preconditions related to Korea's situation when she developed the item. Therefore, it is wrong to assert that only specific directions are correct. However, she did not realize that the way she wrote the question could cause problems, and the CoP activities failed to assist Teacher D's PD. However, it was found through the interview with Teacher D that the problem was not related to her identification with the community.

Researcher: How did the students respond to modifying the scoring criteria?

Teacher D: When I told them that Teacher C made me score the wrong answers as correct, the students liked it very much.

Researcher: So what are you going to do next?

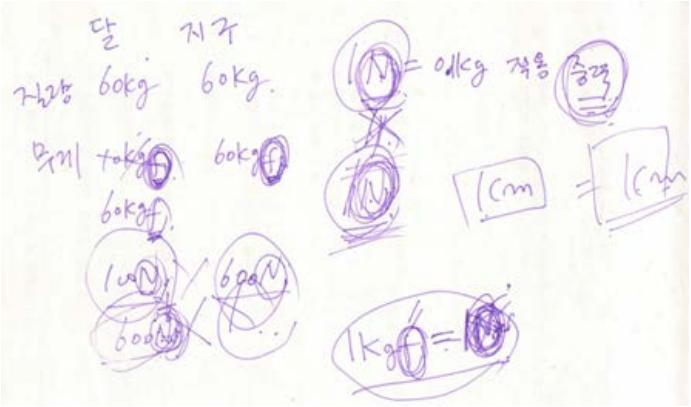


Figure 3. An example of notes taken in Community 1

Teacher D: If I form a community with other teachers, the scoring criteria will be changed. If they are in agreement, answers with wrong spellings or units will be treated wrong.

(Interview with Teacher D on June 30, 2011)

In Community 2, where there was only superficial agreement and no internal consensus, the root cause was the lack of mutual respect between the teachers.

Learning Partnership. Teacher A and Teacher B, who were both physics majors, showed the process of teacher PD through positive interactions and learning partnership in the CoP. They stimulated their PD through active participation in the community and discussions within the zone of proximal development (ZPD). These interactions were particularly evident in Process F. The following conversation was recorded in Community 1:

Teacher B: I had a question while scoring the answers. "F" means force. Is this symbol used only on Earth? Or can we use the symbol for force on the moon?

Teacher A: Normally "f" is only used on Earth because the meaning of "f" is 9.8.

Teacher B: Does "f" simply mean gravity acceleration? The value of gravity acceleration varies from Earth to the moon, but the moon also has gravity.

Teacher A: I think that "f" is only used on Earth. I have never seen "f" used elsewhere.

Teacher B: "Kilogram" is a unit of mass. I thought that wherever gravity acts on the mass, it represents gravity acceleration.

Teacher A: I never thought of that. Now that I think about it, I am not sure whether "f" is only used on Earth. But the item asked to compare the force of Earth and the moon. If you marked "f" for both situations, we would not be able to distinguish them. So, you should mark it as wrong.

(Community 1 on September 28, 2011)

An example of notes taken from a discussion in Community 1, shown in **Figure 3**, provides evidence of the learning partnership that existed within that CoP.

An important goal of assessment is feedback on student achievement. It also includes motivating further learning by providing a sense of satisfaction or accomplishment. Teacher C had a better understanding of the function of evaluations than Teacher D, and the bad scores did not help the students improve their learning. It is not ideal to diminish students' motivation to learn through bad scores. Teacher C had a better understanding of students because of his many years of teaching experience. His understanding of the students influenced his

opinions of the scoring criteria. However, Teacher D did not clearly understand the intentions of Teacher C for lowering the scoring criteria. Teacher C explained his opinion on the matter in an interview with the researcher:

> Teacher C: Since the students' thoughts are so diverse, there are too many unintended answers. However, when I read the students' answers as a whole, even though they did not match my expectations, I saw that meaningful learning had taken place, only that there were many misrepresented expressions. For example, in science, units are important. Of course, I think spelling is not important because it is a foreign language. It's a matter of pronunciation. But very few students have unit concepts. If you do not write a unit, you can only give a half score according to the scoring rubric that the teachers agreed to use. Then the students will be disappointed. The role of the assessment is to convey a message of caution to the students, but this does not work. So even if the unit is wrong, I will give those a full score. Half of the reason is to make scoring easier for me and the other half is to satisfy students with the scores.
>
> (Interview with Teacher C on June 30, 2011)

Teacher C developed his professional knowledge of students through the assessment process. However, Teacher D showed a negative attitude toward Teacher C because she thought Teacher D had less professional knowledge. She explained her attitude as follows:

> Teacher D: I do not agree with Teacher C. I think that students should not misspell their answers. But Teacher C treats those answers as correct. Teacher C made the scoring rubric easy after he made the test items difficult. He wanted to treat everything as correct answers if he found anything correct in them. But I cannot stand it. So I kept on arguing, but in the end, I agreed with Teacher C. That's the only way to raise the rate of correct answers. If the rate of students' correct answers is too low, it is the teachers' problem because it shows that their professional knowledge is poor.
>
> (Interview with Teacher D on June 30, 2011)

Mutual trust and respect are important factors in learning partnerships. If there is no mutual trust and respect among member teachers of a CoP, the teachers' PD cannot progress.

DISCUSSION

In this study, we investigated teacher CoPs in the process of developing assessment items, scoring, and providing feedback to students on the results. Throughout the study, we explored the PD of teachers within the community, and the factors to promote the efficient operation of a teachers' CoP. In this study, we found reflection, cooperation, conflict, identification, and partnership. The partnership in a CoP may be collaborative and harmonious, or it may be antagonistic and conflictual (Wenger, 2000). However, these complex and dynamic interactions did not guarantee the development of teachers' professional knowledge within the CoP. As a result of these interactions, we identified two different types of community implementation: challenge and routine.

At all stages of the assessment activity, the teachers considered their colleagues to ensure that low professional knowledge was not exposed. This appeared to be cooperation on the surface, but it did not aid in the growth of teacher PD. Cooperation for teachers' PD in a CoP involved solving the conflicts that arose within the community. Conflict resolution occurred when colleagues perceived each other as learning partners. This study revealed the importance of this partnership for teachers' PD in a CoP by presenting a case of a harmonious partnership and a conflictual one.

The difference between the two CoPs was clearly revealed from the identification of the members with the community. In Community 1, the teachers recognized the problems that arose in the assessment process as their own responsibility. This is a very important point. When a teacher assumes the responsibility for a problem because of his or her own lack of professional knowledge, this leads to PD. On the other hand, the teachers in Community 2 blamed their colleague for the problem in the community, and no real reflection or PD occurred as a result.

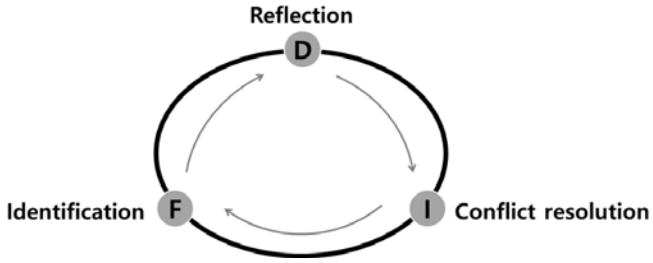


Figure 4. Challenge practice

Type I: Challenge Practice

Learning within a teachers' CoP should be challenging to incur professional growth. In addition, the learning must be cyclical. Challenge practice was observed in Community 1, consisting of Teacher A and Teacher B. Positive interactions between the teachers were continually observed in Processes D, I, and F for student assessment. Moreover, growth of the teachers' PD was easily observed. We called this type of practice challenge practice. In challenge practice, teachers engaged in activities of the community and developed their professional knowledge. The process is illustrated in **Figure 4**.

During this process, cooperation between the teachers was not always easy. For example, subsequent exams were planned based on the teachers' experience planning previous assessments. This caused a great debate and the teachers were only able to reach a consensus after lengthy discussion.

According to Kunzman (2003), conflicts can arise in teacher CoPs due to differences in teaching experience. Middle school teachers tend to think negatively about their students (Lewis et al., 2015). Teacher B in Community 1 and the teachers of Community 2 tended to have lower expectations for the students' abilities, while Teacher A had higher expectations for student achievement. It became clear that the debate occurred due to the teachers' different understandings of the students. This cycle has continued, and through these challenges and failures, the teachers were able to develop their professional knowledge.

Initially, the practice of the two teachers in Community 1 seemed unstable. They made many assessment decisions based on past experiences. However, their professional knowledge levels were not high. Through the conflict between the teachers in Community 1 and their reflection on their practice, they assessed their own beliefs (Lyon, 2011) and began to see their activities from a different point of view (Mitchell, 2015). This means that they were not passive participants, and that they acted as researchers by actively participating in a CoP (Erickson et al., 2005; Flint et al., 2011; Mitchell, 2015). Teachers' PD can be improved through peer interaction (van Driel, 2010). This is because teachers can exchange personal reflection with their colleagues based on their own experiences (Pintrich, Marx, & Boyle, 1993; So, 2013; Tillema, 1997).

We have confirmed the implementation of the challenge practice in Community 1 as a result of various types of interactions in Process D, Process I, and Process F. These reflections could help teachers to judge their level of professional knowledge and help them to understand how their knowledge affects their teaching and assessment practices. As a result, they were able to develop their professional knowledge within the practice community (So, 2013). They also accepted the results of the assessment as their own responsibility and identified with the community. Identification with a community can make a member vulnerable to its power dynamics. (Wenger, 2000). Reflection and identification are also inseparable (Wenger, 1998).

In order to be able to perform challenging practice, it is important to establish mutual trust and respect within the teacher community and to respect each other's professional knowledge. Mutual trust and respect provide the solid ground from which unanticipated problems related to student assessment, which may stem from a lack of professional knowledge, can be effectively resolved.

Type II: Routine Practice

Routine practice was observed between Teacher C and Teacher D in Community 2. Because they avoided confrontation through superficial interactions, they did not have the chance to develop their professional knowledge. Teachers can acquire new knowledge in a CoP, but the teachers in Community 2 failed to do so because of their misunderstanding of the students and their previous experience. In addition, they did not try to understand the reason for the failure through self-reflection. They chose to externalize the cause by blaming, for example, the other teacher's lack of professional knowledge (Grossman et al., 2001; Weiner, 2010).

In this community, the performance of the two teachers appeared to be stable. They achieved the expected results with minimal effort and thus reinforced their daily practice with this repetition. For example, if conflicts occurred, the teachers did not discuss it deeply and quickly resolved the conflicts by lowering the agreed-upon scoring criteria.

Wenger (2000) insisted that "conflict is a core part of practice" and Dooner et al. (2008) suggested that conflict can facilitate problem solving and understanding of alternative perspectives. Some conflict is healthy, stimulating problem solving and helping to understand alternative perspectives within the teacher communities. However, if these conflicts move to personal attacks and suspicion, and distrust penetrates the collaborative process, the community collapses and leaves members desiring to leave the community (Dooner et al., 2008; Jones et al., 2013). As such, Wenger (1998) also warned that conflicts can be potentially harmful to the teacher community.

In Community 2, we observed that Teacher C avoided conflict and failed to establish meaningful cooperation due to a lack of respect for his colleague. According to Kunzman (2003), there are five main topics in experienced teachers' learning, one of which is the importance of collegiality and collaboration. However, when there is a lack of respect among colleagues, it may not be possible for teachers to develop professional knowledge through collaboration or conflict in teachers' communities.

Some teachers have reported that they avoid interactions with colleagues with problematic dialogue skills in teacher communities (Jones et al., 2013). Teachers do not wish to participate in communities that involve aggressive or uncooperative teachers. If these problematic interactions are not resolved, the teachers' community will not have a positive impact on teacher PD. It is a challenging task for researchers to solve this problem because critical dialogue has a powerful function that interferes with the teacher's discourse (Carver & Katz, 2004; Clandinin, Downey, & Huber, 2009; Pomson, 2005). Thus, critical dialogue was called "unnatural work" by Ball and Forzani (2009). The teachers of Community 2 thus faced a problematic situation.

It is the mutual trust and respect between teachers that should be constructed first in order for conflict in a community to lead to positive development of teachers' professional knowledge. Because conflicts in a community are solved by considering other members' positions or opinions, when there is a lack of trust and respect among the teachers, conflicts can be perceived as personal attacks. In that case, conflict resolution through discussion may not contribute to educational growth or the development of teachers' professional knowledge. In such cases, community discussion may not be productive. In Community 2, few productive interactions were observed.

In South Korea, middle school science teachers have to teach physics, chemistry, biology, and earth science, but teachers major in only one of these subjects. A lack of knowledge in a non-major field can lead to teacher conflict over assessment; thus, conflict, such as that which occurred in Community 2, is common. For that reason, we called this type of practice routine practice. In routine practice, non-major teachers superficially participate in the interactions of their community, while mainly the subject-major teachers make the teaching materials, assessment items, and share them with the other teachers. The process of routine practice is illustrated in **Figure 5**.

Weak interactions between teachers were continuously observed in Process D, Process I, and Process F, and facilitation processes for teacher professional development were not easily observed.

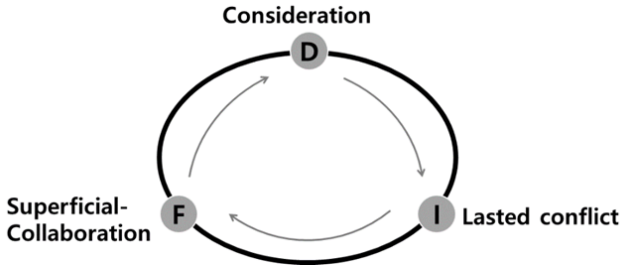


Figure 5. Routine practice

CONCLUSIONS AND IMPLICATIONS

Teachers should have the capacity for collective growth as well as individual growth. A teacher's community plays a very important role in raising these competencies. Teachers need opportunities to engage in genuine activities and rigorous and controversial discussions within the community. It is especially important to consider the factors that influence teacher PD in order for dynamic community activities to take into account various aspects of the teacher's personal perception, social interaction, and learning environment. We searched for complex and dynamic variables in this study to explore how teachers develop professional knowledge from their relationships in the community.

Assessment affects all levels of the education system and is an important catalyst for reform of the science curriculum and teaching strategies. This study examined teacher's interactions within CoPs for student assessment, and investigated which factors positively influenced teacher PD. Teacher responses to interactions within communities vary. Particularly, conflicts can be resolved or perpetuated depending on whether they are using challenge practice or routine practice. The most crucial factors found to influence this were mutual trust and respect between the teachers.

In most cases, it was more important to consider other teachers' points of view than the students' learning while resolving conflict in the community. This teacher-centered thinking implies a low level of professional knowledge. The professional knowledge of these teachers was reinforced by their past experiences. The easiest path for the teacher was adopted first rather than a harder path requiring more professional knowledge (Lewis et al., 2015). Reflection from past experiences changed teachers' behavior toward producing items that asked a single and simple answer of the students.

Many studies (Akerson et al., 2009; Daniel, Auhl, & Hastings, 2013; Jones et al., 2013; Thomas & Pedersen, 2003; Vescio, Ross, & Adams 2008; Wenger, 1998) have suggested that reflection may have a positive effect on teachers' professional development. However, this finding confirms that teachers' reflective thinking from past negative experiences may interfere with teacher PD.

However, the community resorted to challenge practice only when there was mutual trust and respect between the teachers, in which the teachers' professional knowledge was developed. In the absence of mutual trust and respect between teachers, the community resorted to routine practice, and their professional knowledge was not developed. In particular, teachers were trying to avoid negative reactions from other teachers in the community.

Although the professional development of teachers is an objective of the community, professional knowledge will not develop if teachers simply cooperate with each other to avoid conflict. The community should provide opportunities for teachers to examine their practice from an unconventional perspective in order to improve their professional knowledge. This experience can be either positive and negative depending on the nature of the teachers' cooperation.

Obstacles that interfere with teachers' PD are other teachers and the students. In both CoPs, the reason why the teachers chose not to admit to their own mistakes was their concerns for parents and students. This phenomenon arises from collective responsibility for student learning. Teachers in CoPs must collaborate in

curriculum and classroom planning as well as in assessment implementation. If they work on challenge practices while discussing their opinions to develop their PD, they will have more productive outcomes. If the process of resolving conflicts among teachers within CoPs is consistent across all areas of curriculum, teaching, and assessment, the teachers' PD will make student learning and assessment more effective.

Mutual trust and respect in CoPs are very important factors in resolving conflicts, and it is very important to experience learning partnership in and identification with the community. If the teachers' PD or past experiences in the CoP are similar, conflicts rarely occur. Since Korean science teachers are aware of the Korea national curriculum and the national standards of assessment, there are few differences in their PD and assessment experience. In particular, teachers have a common belief in knowledge assessment. It is therefore difficult to observe conflict situations that arise from different beliefs and PD.

We were fortunate to observe serious conflict between the teachers in this study. Through our observations, we found that it is important to strengthen the community by establishing a collaborative environment in which teachers can resolve conflicts openly and effectively with mutual trust and respect. Teachers' PD can occur more effectively through the resolution of conflicts with colleagues than by teaching students in isolation. However, this study has limitations. Here we focused on the potential conflicts between teachers in the CoPs that emerged from unintended consequences. After the school year, we expected that the teachers would continue their practice in the new communities. However, the teachers of Community 1 did not continue the challenge practice they had achieved before.

This means that the one-semester duration of the study was not long enough to acquire the competencies that would affect the professional development of other teachers. Therefore, it is necessary to have enough time to establish the challenge practice in the community for the teachers' PD. For this, school administers should provide encouragement for this kind of practice, considering the school's situation. In particular, the professional development of individual teachers within the community is possible through mutual respect and trust of colleague teachers, but in a complex school reality, substantial support is needed to realize these conditions.

Hord (1997) noted that "individual and community improvement is enabled by the mutual respect and trustworthiness of staff members." In particular, younger teachers are more likely to think that their professional knowledge related to content is superior to older teachers. Therefore, in order for beginning teachers to develop professional knowledge through interaction in the teachers' community, they need to learn the importance of mutual respect and effective conflict resolution.

Recently, the numbers of CoPs for teacher PD has increased in South Korean schools. Therefore, this study offers important implications for teachers' PD through community conflict resolution. Younger teachers, in particular, need to learn productive ways to resolve conflicts with experienced older teachers. However, at the same time, experienced teachers should also recognize the value of interaction with younger teachers. Some experienced teachers reported disappointing and unacceptable sharing experiences (Jones et al., 2013). To solve this problem, school-based support for establishing effective teacher CoPs is needed.

Finally, a limitation of this study was a lack in the diversity of members in the CoPs. In South Korea, members of student assessment CoPs are largely constricted to teachers of the same grade level and subject. Therefore, the results of this study may not be generalizable to other countries.

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