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Implementing Microteaching Lesson Study with a Group of Preservice Science Teachers: An Encouraging Attempt of Action Research

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ABSTRACT

This study was conducted to enhance a small group of preservice science teachers' (PSTs') pedagogical content knowledge by adapting microteaching lesson study into Science Teaching Laboratory Applications course. The study was an action research including the researcher and 15 PSTs. Data was collected through video recordings of teaching practices, pre-practice group reports, post-practice individual reports, group interviews and the lecturer's notes. Content analysis was implemented for data analyses. Results showed that microteaching lesson study practices positively contributed to PSTs' development of subject matter knowledge, knowledge of learners, knowledge of representations and pedagogical content knowledge. However, participants' deficiencies in subject matter knowledge limited the effects of these practices. Implementing microteaching lesson study considering PSTs' qualifications related to subject matter knowledge was suggested for science teacher education programs.

Keywords:
Preservice science teachers, microteaching lesson study, pedagogical content knowledge, action research

Introduction

Teachers are critical components of science learning environments in terms of several respects such as their contributions to students' meaningful learning and aiding students for constructing their own knowledge (Heck, 2009). A plethora of researchers have been recognizing this vitality; therefore, they have been investigating (preservice science) teachers' beliefs (e.g. Pajares, 1992), knowledge (e.g. Shulman, 1986) and practical development (e.g. Fernandez, 2005) for decades. As contemporary science teacher educators, today, we can say that one of those previous researchers' aims is that science and technology literate citizenship can be supported by science teachers who hold contemporary (constructivist) beliefs and knowledge and experiences about learning and teaching. Considering this aim, we need to investigate both preservice and inservice teachers' beliefs, knowledge and professional development.

Today, constructivism is accepted as the driving theory of learning (Baviskar, Hartle & Whitney, 2009). Many countries adopt educational reforms encouraging constructivist science learning environments. Certain researchers accept that teachers are the keys for credibility of educational reforms (Van Driel, Beijaard & Verloop, 2001). Bahçivan (2014) have evidenced that Turkish preservice science teachers (PSTs) have still traditional conceptions of teaching and learning science, so teacher educators can expect inservice teachers already hold these traditional conceptions. For example, by a multiple case study, Bahcivan and Cobern (2016) showed that some Turkish inservice science teachers hold traditional conceptions of teaching and learning science. Also, certain studies have evidenced that Turkish PSTs are missing in their pedagogical content knowledge (PCK) (Canbazoğlu, 2008; Uşak, 2005). Mıhladız and Doğan (2017) proved that Turkish

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preservice science teachers' self-efficacy beliefs directly predicted their PCK qualifications. In other words, their PCK deficiency was caused by their non-assertive teaching beliefs. PCK is known as the core knowledge of teachers' classroom practices, so it should be targeted and developed for contributing to the educational reforms positively. Considering the fact that science teachers' PCK significantly relate to their practices of reformed science teaching (Park, Jang & Chen, 2011), we need to find ways to support PSTs' PCK. In this regard, the purpose of this study is to enhance a small group of Turkish PSTs' PCK and teaching practices by adapting microteaching lesson study into a science teaching laboratory course.

Pedagogical Content Knowledge

Pedagogical content knowledge (PCK) was firstly defined by Shulman (1986) as a missing paradigm about teacher knowledge which actually constitutes a critical part of students' learning. As a special amalgam of content and pedagogy, PCK involves teachers' knowledge about ways of representations and students' learning related to a specific topic or concept (Shulman, 1986; 1987). Indeed, PCK, associating teachers' different types of knowledge focused on a specific topic, have corresponded to a big gap in teacher education; therefore, have taken science teacher educators' attention for three decades.

Science education researchers have enlightened several aspects about PCK. Firstly, PCK constitutes the core knowledge of (preservice) science teachers' practice, so its development should be supported in science teacher education (Cooper, Loughran & Berry, 2015; Magnusson, Krajcik & Borko, 1999). Professional development programs seem to be effective in this direction (Yoon et al., 2006). Secondly, science related subject matter knowledge (SMK) is accepted as prerequisite for a qualified PCK (Geddis, Onslow, Beynon & Oesch, 1993). In his pioneering study, Shulman (1986) have already defined PCK as a type content knowledge. Thirdly, a plethora of researchers have constructed PCK models to reveal its components and structure. Gess-Newsome (1999) has discussed properties of these PCK models and offered two different types which are integrative and transformative. In accordance to an integrative model PCK is the integration of other types of teacher knowledge such as knowledge about students' learning, knowledge about curriculum and SMK. Therefore, PSTs should be supported in terms of development of these types of teacher knowledge and encouraged to integrate them considering contextual requirements of science learning environments (Cochran, DeRuiter & King, 1993; Park & Oliver, 2008). On the other hand, a transformative PCK model accepts that PCK is a transformation of other types of teacher knowledge which are useful only when they are synthesized into a unique PCK. Certain studies (e.g. Nilsson, 2008) have evidenced that a problematic component of PSTs' PCK make difficult the acceptance of PCK as a product of transformation process; because, it needs a longer time duration of practice in comparison to integration. Therefore, integrative models explain PSTs' PCK more appropriately whereas transformative models are appropriate for inservice science teachers' PCK. In addition, all the PCK models involve different types of components such as general pedagogical knowledge, subject matter knowledge, curricular knowledge, knowledge of learners and knowledge of representations. Lee and Luft (2008) make a comprehensive comparison of all PCK models and conclude that all the models have a common idea that PCK involves knowledge of learners and knowledge of representations. As a final, similar to other domains, in science education there is still a growing interest in as well as debate about assessment of PCK (Bahçivan, 2012). Baxter and Lederman (1999) state that researchers generally use one of two different types of PCK assessment approaches: qualitative and quantitative. Quantitative designs mostly base on paper and pencil instruments and seem more appropriate for large-scale assessments but have problems in finding international teaching standards (Carlson, 1990; Kromrey & Renfrow, 1991) and have inadequacies in presenting tacit nature of that knowledge (Baxter & Lederman, 1999). On the other hand, qualitative designs mostly involve case studies which empower researchers' hands in terms of data triangulation by different types of data such as lesson plans, classroom observations and interviews. Although, these designs are time consuming and may require high amount of investments, they are case sensitive and draw a more realistic picture of classroom teaching in small sample studies.

Microteaching Lesson Study

Microteaching, a method of preservice teacher development, creates opportunities for preservice teachers to practice a teaching method in artificial learning environments that comprise their peers as learners (Etkina, 2010). Before the practice, PSTs generally have lesson plans to teach. Following individual teaching activities, they receive their lecturers' and friends' suggestions. In this method, opportunities increasing their success are maximized while the risk factors, potential for nonsuccess, are minimized (Görgen, 2003). Studies have evidenced that microteaching activities support PSTs' development of PCK, technological pedagogical content knowledge, knowledge about reform based teaching methods and SMK (Etkina, 2010; Niess, 2005).

As different from microteaching, lesson study is the Japanese style of professional development method for inservice teachers (Eraslan, 2008). In this method, the focus is not on teaching skills as in microteaching, the focus is on students' learning since planned teaching practices are implemented in real classrooms (Cavin, 2007; Eraslan, 2008). Inservice teachers plan a teaching activity in groups (involving at least 3 teachers for most of the times) and one of them implement the plan while other group members observe the practice. Then, the group members discuss the plan and make certain modifications considering the results of these discussions. Afterwards another member of the group implements the new plan to different but a similar group of students. This circulation lasts till to observe desired student learning outcomes (Cavin, 2007; Eraslan, 2008). Studying in groups, making reflections and modifications are accepted as the advantages of this professional development method (Cavin, 2007).

In addition to these methods, microteaching lesson study, a pragmatist blend of microteaching and lesson study, is a preservice teacher training method (Fernandez, 2005). Microteaching lesson study takes advantages of both of the aforementioned methods. Giving a practice opportunity to PSTs in an artificial learning environment, this method promotes their teaching skills (that characteristic come from the microteaching method). Also, studying in groups, making reflections and modifications on the practice comes from the lesson study. Researchers previously stated that microteaching lesson study supports development of preservice teachers' reform based teaching method knowledge, PCK and SMK (Fernandez, 2005; 2010). Qualitative data proved that this method was also found effective by preservice teachers on their practical knowledge (Fernandez & Robinson, 2007).

Significance of the Study

Significance of this study can be explained by several ways. First, as science teacher educators we need to share experiences promoting PSTs' knowledge, beliefs and practice of contemporary teaching approaches. This study was conducted with the participation of Turkish PSTs, but the results can also be useful for other teacher educators from different domains and countries. In latter part of the study, the context of this study will be clarified in detail. Following researchers may take into consideration possible differences between the current context of this study and their own contexts. Second, researchers studying to adapt microteaching lesson study mostly explain their designs as qualitative or experimental. However, method researchers divide qualitative designs into 5 different categories (i.e. Creswell, 2007), so the researchers stating that they implemented a qualitative design should select an approach among those 5 approaches. In general, these researchers make a quasi-experimental study involving qualitative data. Therefore, it can be stated that there is a requirement for action-research studies in this area, because action research studies involve a systematic intervention which will be explained in the method section. Also, science teacher educators study the work of others (i.e. preservice teachers) within other research designs. On the other hand, action research studies transform participants to researchers so that these participants (as insiders) may present invaluable contributions to academic knowledge. Third, structure and development of PSTs' PCK together with its effect on teaching practice still require deep and triangulated evidences. This action research study will contribute to this deficiency in the literature. Considering the purpose of this study following research question was prepared to guide the study:

What are the effects of microteaching lesson study on PSTs' PCK?

Method

This study has a methodology of action research which promotes collaboration among all insiders having the same purpose. Elliott (2001) and Somekh (2006) state that in action research studies, researchers have inquiry-based action plans which should be constructed and developed by contribution of insiders. The main purpose of action researchers is to enhance practice rather than to produce knowledge. The focus is mostly on the processes instead of results.

Context and Intervention

This action research study was realized by participation of 15 PSTs taking the course of Science Teaching Laboratory Applications II course. All the PSTs are female and 3rd year undergraduates. In Turkey, PSTs take subject matter courses about physics, chemistry and biology in first two academic years; therefore, the participants had already successfully passed those subject matter courses. All the Turkish PSTs will teach the science content to 5th-8th grade after their graduation. The purpose of the Science Teaching Laboratory Applications courses is to encourage PSTs to teach their future lessons in a school laboratory medium. Considering this purpose, the course has a science laboratory medium which contains laboratory equipment of three major science domains (physics, biology and chemistry).

To construct the systematic intervention of this action research the five steps offered by Elliott (2001) were followed. The first step is *general idea* meaning that each action research study should have general idea about at least one developable action. The lecturer invited the PSTs to participate in a research study aiming to increase effectiveness of the course and stated that all the-participant PSTs and the lecturer would shape the next actions and decisions together. In this regard, the researcher started a whole class group discussion focusing on the effectiveness of the course on their teaching qualifications. The participant-PSTs were requested to feel themselves as a researcher. Therefore, the general idea of this study is to develop implementation of the course content to contribute to PSTs' PCK qualities and teaching practices more effectively. The second step is called *reconnaissance* which involves being conscious of the context and the developed action. The same PSTs took the Science Teaching Laboratory Applications I course in the previous semester. These 15 PSTs took the following course in the second semester from the same lecturer who is the researcher. During the first semester and the first half of the second semester the PSTs made individual microteaching activities which lasted approximately 20 minutes. Following each activity they received critiques from their peers and the lecturer. During this time, not only the researcher but also the participant-PSTs have the opportunity to observe the course context in detail. Additionally, each PST observed her peers. In other words, the PSTs of this research have had microteaching experiences since the beginning of the first semester. The whole class discussion triggered participants' awareness related to effectiveness of microteaching.

Third step of an action research is called as *general plan* in which insiders make discussions to construct an action plan. During the course time PSTs had not reflected their peers' and the lecturer's critiques to their following individual microteaching activities previously. At the end of the first half of the second semester, the researcher called the PSTs into the whole class discussion about how to increase the effectiveness of this course on their future teaching practices. The participants wanted to study in groups and repeat the teaching activities after modifications considering the critiques. At this point, the baseline of the course shifted microteaching lesson study. The researcher moderated the discussion and all the participants accepted to be part of this research study. According to the plan, PSTs were voluntarily divided themselves into three groups (each included five participants). All the groups selected at least one curricular objective to teach by a microteaching lesson study activity. Modifications of the groups were decided to proceed until each group presented a qualified teaching of the selected objectives during the classroom discussion. Participants also decided to implement their lesson plans by a selected group member. Therefore, participant-PSTs decided to change the course practice from a classical microteaching activity to microteaching lesson study by themselves. Their reasons for change were triggered by the whole class discussion and based on their previous experiences about the course. During constructing this general plan, the researcher limited the participants to select their teaching objectives only from 7th or 8th grade national science teaching programs since their objectives involve more abstract concepts than the previous year programs; therefore, the PSTs would have more opportunities to observe and modify their content knowledge.

The next step of an action research is *developing next action steps*. This step of this research actually deviates from a regular action research study. Because participants of a regular action research study, at this step, should develop next actions considering their whole experiences within their current contexts, so the nature of the intervention is expected to change. However, in this study the general plan (which was the previous step) dominated this step. Following each teaching activities group members received the critiques from their peers and the lecturer as decided previously. Additionally, group members accepted to have a meeting at the lecturer's office once a week to review their next action steps. However, the last step of the action research study is *implementing next action steps*. After deciding and developing the next action steps each group implemented these planned actions in front of the others. These implementations proceeded with a circulation of developing and implementing next actions. This step was also decided during the whole class discussion. During the whole intervention each group realized two circulations. That is a group of students made teaching practice about their first objective(s) which took three weeks and the same group selected different objective(s) from the national science teaching program to teach it for the following 3 weeks.

Data Collection

Data was collected for 7 weeks through four different ways: interviews (audio-recorded), laboratory reports, video records and the lecturer's observation notes. Each group had one meeting time at the lecturer's office once in a week. Each group was interviewed 7 times. The first interview was made to learn about their beginning plans and to support if they need any assistance. The next five sessions were realized just a few days later than their teaching practices. In these interviews each group were requested to clarify how they understood the critiques and what type of modifications they would make for the following weeks. And the last interview session was arranged to learn their ideas about implementing microteaching lesson study in this course together with member checking. All the interviews had a semi structure nature and were recorded by an audio device. Each of the interview record took 19 minutes on average.

Participants were requested to prepare two different reports for each week. The first one is the pre-practice group report which was similar to a regular lesson plan having different parts asking for the objective(s), materials, subject matter knowledge, timing and materials of the planned course. The second report, a post-practice report, was prepared individually by each group members. This report requested the PSTs respond to how they would teach the same objective(s) to the same students if they had another chance together with their reasons. Each of the forms of these reports was prepared by the researcher and distributed electronically to the participants one week before starting the microteaching lesson activities.

Each of teaching practices were recorded by a video device and also distributed to the all group members individually. Each group realized teaching practices six times in total and so they had six recordings. Each of these recordings took 36 minutes on average. The last data source was the lecturer's notes which involved important critiques and expectations from each group, a summary of the whole practices and improvements in participants' observed practices.

Data Analysis

All the audio and video recordings were transcribed verbatim before the analyses. Content analysis was utilized in order to achieve a comprehensive analysis of the whole dataset. Krippendorff (2004) mentions that content analysis can be adapted to analyze any type of text materials if these texts involve use of language. Considering the data and the literature aforementioned coding units were decided at the beginning (see Table 1). Each of coding units should include categorical distinctions (Krippendorff, 2004). All the dataset were carefully read by the researcher two times by taking notes. Aforementioned literature stresses that PSTs' PCK involves their knowledge of learners and knowledge representations. Also, PCK is affected by their SMK. Moreover, the literature does not give any internationally valid and accepted categorical distinctions for PCK because of the problems about assessment of this construct. Therefore, the researcher decided to adapt a three label categorical distinctions for PCK: qualified, support and missing. These categorical distinctions were also utilized for other coding units to catch a harmony among coding units during analyses. To illustrate, 'qualified' was utilized to label a well-developed SMK. 'Support' was the label of PSTs needing a professional assistance to have a better SMK and 'missing' was used for the ones whose SMK had vital problems. The coding results from SMK, knowledge of learners and knowledge of representations units were, then, utilized to attain codes for the PSTs' PCK.

For example, if a PST's SMK, knowledge of learners and knowledge of representations were coded as 'missing', his/her PCK was also coded as 'missing'.

Table 1. Content of the content analysis

Coding Units	Categorical Distinctions	Intercoder Reliability
Subject Matter Knowledge	• Qualified • Support • Missing	.84
Knowledge of Learners	• Qualified • Support • Missing	.92
Knowledge of Representations	• Qualified • Support • Missing	.82
Pedagogical Content Knowledge	• Qualified • Support • Missing	.85

In content analysis studies member checking and data triangulation was suggested to validate the interpretations (Creswell, 2007). Participants were informed about some of the labels attained to them during the last interview for member checking. Additionally, multiple data sources were examined to be able to achieve data triangulation. For examining intercoder reliability (reproducibility) Krippendorff's α was calculated for each coding unit. For this purpose, sample of quotations were randomly presented to another science teacher educator by the researcher after clarifying meaning of the categorical distinctions presented above. The second researcher was requested to match the categorical distinctions with the presented quotations. Then, the researcher of the study calculated the Krippendorff's α values (see Table 1). Krippendorff (2004) states that α values larger .80 points to high reliability; therefore, it can be said that data coding procedures adapted in this study had reproducibility.

Results

Subject Matter Knowledge

PSTs' SMK was coded as mostly missing and support at their first teaching practices. To give example one of the groups had selected two objectives from topic of electricity from 7th grade science teaching program. One of their objectives requested them to make their students explore the relationship between brightness of lamps and the types of lamps' connection. These students' teaching practices, first interviews and their individual reports proved that they did not differentiate the mathematical formula of ohm's law from the mathematical formula of power of lamp. SMK of this group of students was labeled as mostly missing. Second group selected a different objective from the same topic about charging types in electricity. These students believed that neutral objectives do not involve any type of charge. In addition, they had other misconceptions generated during the data collection procedures. Therefore, their SMK were also coded as missing most of the times. Moreover, the last group's objective was from a biology topic which was about the structure of DNA. They presented different types of DNA models to the students during their teaching. After finishing teaching practice, the dialogue, shown below, was occurred between the group and the lecturer.

- Lecturer: You utilized DNA models. What are the differences between your models and the real DNA.
- Student: They are the same…..
- Student: Difference?.....Nothing.
- Lecturer: The same? But, your models involve some colorful parts.
- Student: Got it. The model and a real DNA are very similar to each other.
- Lecturer: Got it! But what are the differences between them tell me as much as you can.
- Students: ……………..?

This group of students' SMK was mostly labeled as support. This is most probably because they selected their learning objectives "…..among the ones which we feel ourselves powerful about the details of that objective". On the other hand, the other two groups of students stated that they selected especially the objectives about which they have weakness to catch a developmental shift in the course.

During the course time following their teaching practices and in interviews, the lecturer directed certain questions to make suspicious them about their current knowledge. PSTs made research in libraries, science textbooks and internet. They sometimes requested certain explicit answers and secondary sources from the lecturer when they could not produce meaningful comprehension about the objectives. At the end of the course, all the groups were coded as mostly support. The qualified label was just used a few times for the third group which was already coded as support at the beginning of the study.

Knowledge of Representations

PSTs' knowledge of representations was labeled with mostly missing and partly support at the beginning. For example, during teaching of brightness of lamps, the first group made lab experiments. This group prepared a leaflet distributed to students to follow up the experiments and write their observations and answers on it. There were too many experiments having problems in terms of dependent and independent variables. These problems were also detected on their lesson plans. Additionally, when their students had problems with the lab equipment (i.e. about receiving light) they could not assist the students most of the times. This situation caused disconnections in their representations. Another problem about their representations was the high number of experiments and length of the leaflet which caused fatigue and turned their teaching practice into a cookbook activity. These deficiencies were verified not only by their video records but also verified by the lecturer's notes. Therefore, their knowledge of representations was mostly coded as missing.

In the second group of PSTs knowledge of representations was mostly coded as missing, but the situation was different from the previous group. One of their objectives was from 8th grade science teaching program requesting students to make experiments about charging and making observations and inferences about the results of these experiments. Their first teaching practice mostly involved electricity games. For example, they arranged a balloon competition among students. The aim was charging the balloons by friction then stick the charged ones to the blackboard. The group of students stuck the highest number of balloons won the competition. After finishing the competition students were directed into another competition. This data come within their lesson plans, video records and the lecturer's notes. The main problem of this group was their conception of constructivism as playing game with students. Another salient problem with their representations was similar to the previous group. They sometimes could not achieve the charging with the selected materials and such situations caused disconnections in the fluency of representations.

When it comes to the last group, the number of support code is slightly higher than the number of missing codes; therefore, they were labeled as partly support. According to their video records and lesson plans, this group utilized different types of representations such as physical models, electronic presentations and questioning. The main problem with their beginning practice was about their conception of constructivism. Semi structured interviews showed that they accepted constructivism as a theory of teaching rather than learning. In this respect, they thought that there were certain steps in a 'constructivist teaching' such as questioning students' prior knowledge, presenting the body of knowledge and making some hands-on activities. Within such a constructivism conception, they had deficiencies about bridging the steps; because, their focus was on their own teaching rather than on students' learning.

During the course time, classroom discussions about teaching practices and the group interviews contributed positively to PSTs' knowledge of representations. They took advantages of working in groups to enhance their repertoire of representations and attempted to adapt different types of representations considering critiques about their teaching practices. For example, upon the critiques the first group decided to cancel using a complete leaflet. Instead, they decreased the number of lab experiments to make more effective classroom discussions about brightness of lamps. In their last implementation, they distributed just two separate sheets to the students. Similar positive shifts were observed for all the groups. At the end of the course, the first two groups of students' knowledge of representation were coded as mostly support, and the last group was coded as support.

Knowledge of Learners

This part of PSTs' PCK was coded as missing for all the groups at the beginning of the study. According to data of lesson plans and video records as well as the lecturer's notes, there were not any groups of PSTs questioning their students' prior knowledge to understand their readiness, learning difficulties or misconceptions in their first teaching practices. Even if they sometimes observed such points they could not integrate this type of knowledge into their representations. For example, the first group presented a verbal story in which a new-year garnish involving series connected lamps which were not giving light. They questioned the students to find out the reason and produce a solution for the problem. The students could not really find the answer although they were their peers; because, such an example presented an overload in terms of their learning difficulties.

During the first teaching practice of second group, one of the students asked that "Why we should choose pongee rather than woolen cloth in order to charge a glass rod?" The group could not give any answer to the question; because, they were not ready for students' learning difficulties.

Considering the classroom discussions realized after teaching practices, all the groups attempted to transform their teaching ways. They tried to make questioning to investigate students' learning difficulties but still were unable to integrate this knowledge into their teaching effectively at the end of the course. Therefore, all groups were labeled as partly support.

Pedagogical Content Knowledge

PCK was accepted as the integration of other types of knowledge in the study. Therefore, PSTs' PCK labels were attained indirectly based on their codes in other domains. In other words, codes attained to PSTs' knowledge in other components of PCK formed their PCK codes. Table 2 represents all the codes attained to the data together with PSTs' PCK.

Table 2. Overall results of the study

	Group #1		Group #2		Group #3	
	First Practice	Third Practice	First Practice	Third Practice	First Practice	Third Practice
Subject Matter Knowledge	mostly missing	mostly support	mostly missing	mostly support	mostly support	mostly support
Knowledge of Representations	mostly missing	mostly support	mostly missing	mostly support	partly support	support
Knowledge of Learners	missing	partly support	missing	partly support	missing	partly support
Pedagogical Content Knowledge	mostly missing	mostly support	mostly missing	mostly support	partly support	mostly support

Considering the results represented in Table 2 it can be said that PSTs' PCK qualification increased to some extent. Being a part of such an action research study provided them to reflect and modify their teaching practices so increased their PCK qualification. However, PSTs' deficiencies in SMK seemed to prevent them holding more qualified PCK. In following section, the results were discussed in detail. In conclusion, it can be said that microteaching lesson study may contributes to preservice science teachers' PCK development positively.

Discussions

The purpose of this study was to implement the microteaching lesson study to enhance PSTs' PCK and teaching practices. In this respect, the medium of the course context was arranged to support their development. Then, the participants' PCK qualifications were analyzed in-depth. In general it can be said that microteaching lesson study positively contributed to PSTs' PCK development; however, the observations and results need to be discussed.

First of all in this study PCK was accepted as it has an integrative (model) structure. Through accepting such a modeling structure, researchers actually believe that PCK has independent components which are integrated considering the contextual factors (Cochran et al., 1993; Gess-Newsome, 1999). By means of PCK's integrative structure, microteaching lesson study had definitive goals. In other words, integrative structure clarified which components of a PST's PCK had problems. In this way, classroom discussions and the researcher's suggestions instinctively focused on the problematic components.

Consistent with previous studies, SMK of PSTs developed (e.g. Fernandez, 2010). In their first practices it was obviously observed that PSTs had deficiencies in their SMK (see Table 2). Their peers could not contribute much in this respect during the discussions. The researcher attempted to make them being suspicious about their own SMK. Additionally, interviews were functional to make group discussions and providing certain secondary sources for contributing positively to their SMK. In their modified follow up practices, it was obvious that their SMK was developed to some extent; however, this development could not meet the researcher's (the lecturer's) expectations. Because, development of SMK, is actually out of the scope of the course, and needs much more time than the course context could.

Moreover, the problems with PSTs' SMK limited their developments in their other components especially in knowledge of learners. Knowledge of learners already covers knowledge about students' learning difficulties and misconceptions as a different form of SMK (Shulman, 1986; 1987). In this respect, PSTs' knowledge of learners seemed to be limited by their own limitations in SMK. Another problem about PSTs' knowledge of learners caused by the artificial medium in microteaching lesson study implementations. In such an artificial medium, PSTs had certain problems during planning their lesson scopes. Because, their students were their own peers. Most of the times, they thought that their peers knew details of the objectives; therefore, there was no need to questioning these details to produce directives for their teaching activities. This artificial structure together with their limitations in SMK seemed to prevent the PSTs' progress in their knowledge of learners.

As another component of PCK, PSTs' knowledge of representations remarkably developed in comparison to other components. At the beginning of the first practices PSTs mostly focused on their own teaching rather than students' learning. This result was also observed by Fernandez (2010) in the same way. Data triangulation in this study proved that the main reason underlying this fault was the PSTs' problematic conceptions of constructivism that they hold. The first fault was that most of them conceptualized constructivism as a theory of teaching rather than learning. PSTs holding this conception believed that a constructivist teaching had certain steps to follow, but they could not connect these steps to each other, so to students' learning. Another fault about conception of constructivism was reducing 'learning by doing' and 'hands on' tendency in this theory to playing game or making hands on activities continuously. This conception also prevented them to represent the concepts by making connections to students' learning.

Also, PSTs' limitations in SMK sometimes negatively affected their knowledge of representations such as designing experiments with mistaken variables and selecting an inconvenient order of implementation. These observations were also consistent with the researchers who mentioned centrality of SMK for qualified PCK (Geddis et al., 1993). Another problem in their knowledge of representations was encountered because of their deficiencies in laboratory materials. The PSTs often attempted to utilize laboratory materials that they had only partial experiences about them. This deficiency caused problems (such as disrupting fluency) in their representations. Classroom discussions, group interviews and teaching practice cycles provided by microteaching lesson study supplied their knowledge of representations consistent with previous studies (Fernandez, 2005; 2010).

During the interviews of member checking, the PSTs' views and expectations about implementing microteaching lesson study activities were investigated. They stated that being a researcher in this action research study, watching their own video recorded practices, making reflections and modifications on their practice motivated them to experience positive changes in their teaching skills. Most of them admitted investigating their own weak points about SMK as an important opportunity for their future practices. They also felt themselves more efficacious in teaching science by contemporary methods. Additionally, all the PSTs had the same idea that microteaching lesson study activities more positively affected their practical development in comparison to microteaching activities experienced previously. In this respect all their ideas about microteaching lesson study were consistent with what Fernandez and Robinson (2007) stated. As distinct from these positive points, a few of them stated that their personal problems with peers sometimes affected their critiques about practices. Additionally, cycling teaching practices were sometimes felt them boring, if they had difficulties in producing new representations or materials.

In general, researchers holding an integrative approach about the structure of PCK claim that preservice teachers should be presented with teaching practice opportunities to integrate different components of PCK (Cochran et al., 1993; Park & Oliver, 2008). In this respect, the studies about microteaching lesson study (i.e. Fernandez, 2005; 2010) motivated this research which, in conclusion, actually did not only proved its effectiveness on PSTs' PCK development but also evidenced that SMK behaved as a filter on this effect. Participating in microteaching lesson study activities also made positive shifts in PSTs' SMK development but the amount of this shift was limited.

Implications

Considering the results and discussions presented above several implications can be presented. Firstly, PSTs may be given opportunities to change course contents since these opportunities increase their motivation and provide them taking responsibilities about their own development. Secondly, microteaching lesson study can be used more intensively in science teacher education courses. The possibilities about implementing this method should be considered seriously in different courses because of its support on integration of PCK components. However, PSTs' problems in SMK behave as a barrier for effectiveness of this method on their PCK development. These students took subject matter courses in their first and second years at the university. It seems that these subject matter courses should be designed for positively contributing to their conceptual understanding of science concepts and hence to their SMK development. Finally, considering the results, the researcher calls following teacher educators from different domains to implement microteaching lesson study in their courses. Interdisciplinary findings may reveal different advantages of implementing microteaching lesson study in preservice teacher education.

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