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Fen Öğretimine Yönelik Öz Yeterlik İnançlarının Kolektif Yeterlik ile İlişkisinin İncelenmesi*

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ÖZET

Bu çalışmanın amacı, fen öğretmen adaylarının fen öğretimine yönelik öz yeterlik inançları ile kolektif yeterliğin arasındaki ilişkiyi incelemektir. Özel öğretim yöntemleri dersinde kayıtlı dört öğretmen adayı ile bu çalışma yürütülmüştür. Bu katılımcılar, bir grup halinde çalışarak dersin gereklerini yerine getirmeye çalışmışlardır. Bir dönem boyunca, düzenli aralıklarla görüşme yapılarak veri toplanmıştır. Çalışmanın sonunda, kolektif yeterlik kaynaklarının fen öğretimine yönelik öz yeterlik inançlarının iki boyutu olan fen öğretim yeterliği ile sonuç beklentisinin gelişmesinde önemli bir rolü olduğu saptanmıştır. Doğrudan yaşantı kaynağının katılımcılar tarafından sürekli vurgulanması dikkat çekmiştir. Sonuç olarak, fen öğretmen eğitimcilerinin derslerini kolektif yeterlik geliştirmeye yönelik düzenlemesi önerilmektedir.

Anahtar Sözcükler: kolektif yeterlik, fen öğretimine yönelik öz yeterlik inançları, öğretmen adayı, özel öğretim yöntemleri dersi

A Study on Examining Relationship between Pre-Service Teachers' Collective Efficacy and Science Teaching Efficacy Beliefs

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ABSTRACT

It was aimed to investigate the relationship between collective efficacy and science teaching efficacy beliefs of pre-service teachers. The study was composed of four junior pre-service science teachers working together to fulfill the tasks of a science methods course. They were interviewed at regular intervals during one semester. The results revealed that the sources of collective efficacy played an essential role in the development of personal science teaching efficacy and science teaching outcome expectancy of the group members. The participants most emphasized the effect of the positive influence of mastery experience. It was concluded that science teacher educators could consider collective efficacy when designing their courses to improve pre-service teachers' science teaching efficacy beliefs.

Keywords: Collective efficacy, science teaching efficacy beliefs, pre-service teacher, science methods course

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1. INTRODUCTION

Interaction among people, which has been the most important part of their social life, result in development of beliefs about any collective action they will undertake (Bandura, 1997). Congruent with this idea, collective efficacy was formulated. According to the social cognitive theory, self-efficacy was first introduced as a person's belief in his/her ability to achieve a specific task (Bandura, 1997). Then, efficacy construct was extended to group agency as collective efficacy. The concept of collective efficacy was defined by Bandura (1997) as "a group's shared belief in its joint capabilities to organize and execute the courses of action required to produce given levels of attainment" (p. 477). It influences the purpose of the group, the work

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of group members, their commitment to achieve, and perseverance in case of obstacles (Bandura, 1997). Therefore, collective efficacy has been accepted as powerful predictor for level of group performance (Goddard, 2001; Peterson, Mitchell, Thompson, and Burr, 2000).

Bandura (1997) specified four sources for collective efficacy. Mastery experience, which is developed based on the past group performances, is recognized to be the most dominant source of efficacy belief (Bandura, 1997; Palmer, 2006). Previous performance predicts following collective efficacy in group (Myers, Feltz, and Short, 2004). Vicarious experience has been determined as the second source of collective efficacy. Monitoring other groups or people who have corresponding goals and occasion or drawbacks can help develop the level of collective efficacy (Goddard, Hoy, and Woolfolk Hoy, 2004). The third source of collective efficacy is verbal persuasion and depends on feedback from other groups or people about a group's performance. Sorlie and Torsheim (2011) stated that feedback and well-reflected arguments might lead to enhance collective efficacy of members in a group. The last source is physiological and affective states that offer insights into efficacy beliefs by providing information about the present state of the group, such as anxiety, fear, stress, arousal, and mood states. Goddard et al. (2004) affirmed that the kinds of negative situations can decrease the collective efficacy level of group members.

The research on collective efficacy was usually conducted in organizations, sports, and school and university settings. Moreover, the concept of collective efficacy has been mostly examined in terms of relationship between some variables, such as job burnout, job satisfaction, group size, group cohesion, group performance, and self-efficacy. Among these variables, much emphasis has been given to self-efficacy of group members. It has been repeatedly reported that self-efficacy of group members is linked to collective efficacy (Fernandez-Ballesteros, Diez-Nicolas, Caprara, Barbaranelli, and Bandura, 2002; Fives and Looney, 2009; Goddard and Goddard, 2001; Lent, Schmidt, and Schmidt, 2006; Lev and Koslowsky, 2009; Skaalvik and Skaalvik, 2010; Viel-Ruma, Houchins, Jolivette, and Benson, 2010).

Different from the studies mentioned above, Baker (2001) evaluated whether collective efficacy alter over time compared to self-efficacy and found a relationship between self-efficacy of group members and collective efficacy at all six times. Conversely, he observed a decrease in this relationship over time since the success of group become less dependent on the best individual group member gradually. At the same time, all group members started to work more efficiently to contribute to the group success.

1.1. Science Teaching Efficacy Beliefs

Enochs and Riggs (1990) emphasized the importance of teacher efficacy beliefs in science teaching and defined two components that constituted these beliefs; personal science teaching efficacy beliefs (PSTE) and science teaching outcome expectancy (STOE). Ritter, Boone, and Rubba (2001) explained that PSTE referred to the belief in one's ability toward teaching science effectively, and STOE was related to the belief that science teaching would lead to positive outcome in student learning. Science teaching efficacy beliefs are determined as significant predictors of the quality of science teachers (Schoeneberger and Russell, 1986). In line with this idea, plenty of studies have been implemented to demonstrate the role of science teacher efficacy in teachers' behaviors and practices. Firstly, researchers have shown that science teachers with low science teaching efficacy considered science as a difficult subject to teach (Appleton, 2003); disliked, feared, and failed to understand science (Davis and Smithey, 2009; Tosun, 2000); did not have self-confidence to teach science (Mulholland, Dorman, and Odgers, 2004; Van Zee, Lay, and Roberts, 2003); spent less time teaching science (Harlen and Holroyd, 1997; Ramey-Gassert and Schroyer, 1992); held negative attitudes toward science and teaching science (Ramey-Gassert and Schroyer, 1992); and passed their negative attitudes onto their students (Czerniak and Chiarelott, 1990). On the contrary, teachers with high efficacy showed desirable teacher characteristics, such as spending more time in teaching, developing more positive attitudes toward science (Brigido, Borrachero, Bermejo, and Mellado, 2013; Cantrell et al., 2003; Ramey-Gassert and Schroyer, 1992), and adopting a more lenient approach to classroom management (Enochs et al., 1995; Ross, 1994; Soodak and Podell, 1994; Yilmaz and Cavas, 2008). Furthermore, it has been reported that teachers whose science teaching efficacy levels are higher utilized student-centered teaching strategies (Marshall, Horton, Igo, and Switzer, 2009; Mulholland and Wallace, 2001; Palmer, 2001) and improved quality of teaching science (Richardson and Liang, 2008; Utley, Moseley, and Bryant, 2005).

Woolfolk Hoy and Burke-Spero (2005) suggested that once self-efficacy beliefs were established, they would not change easily. Based on this notion, it was claimed that pre-service teachers' efficacy beliefs had an essential implication for future teaching performances (Fives, Hamman, and Olivarez, 2007). Similarly, Carter and Sottile (2002) argued that improvement of the pre-service science teachers' self-efficacy helped them to become qualified. Therefore, a considerable amount of research has been administered with pre-service teachers to enhance science teaching efficacy beliefs (e.g., Bautista, 2011; Gunning and Mensah, 2010; Palmer, 2010).

Considering the importance of science teaching efficacy beliefs on science teaching, collective efficacy may be a significant factor on the development of self-efficacy of pre-service teachers. However, in the literature, collective efficacy of pre-service teachers has only been examined to a limited extent. For instance, Webster, Erwin and Parks (2013) reported that collective efficacy among pre-service classroom teachers was formed to design activities to prevent childhood obesity. Moreover, pre-service teachers' group discussion and performance regarding solving mathematic problems were affected positively by

collective efficacy (Wang and Lin, 2007). On the other hand, there has been limited research about the relationship between collective efficacy and self-efficacy in the literature. Therefore, the present study was conducted with pre-service science teachers to explore the influence of collective efficacy on science teaching efficacy beliefs.

2. METHODOLOGY

2.1. The Context of the Study

This study was undertaken in a state university in Turkey over one semester. As the main context of the study, the science methods course, which is compulsory in the science teacher education program, was chosen. This course aims to teach different science teaching methods by having pre-service teachers prepare lesson plans related to the introduced teaching methods and perform microteachings. One professor and four assistants took part in the delivery of the course. The professor had a Ph.D. degree on curriculum and instruction and had taught this course for ten years. All the assistants graduated from the department of elementary science education, and had taken the same course when they were undergraduate students. At the time of this study, three of the assistants were Ph.D. candidates and one had a Master's degree in science education.

2.2. Research Design

The current study was carried out as a case study allowing the researchers to inspect the relationship between collective efficacy and science teaching efficacy beliefs. Case study, which is one of type of qualitative research derived from postpositivist paradigm, provides an in-depth understanding of the issue that participants are involved (Merriam, 2009). In this process, the case can be natural phenomena as well as designed to reveal a unique situation. Moreover, data should be collected several times to describe the case holistically (Creswell, 2007). Present study included the similar characteristic of case study. For example, firstly, the nature of collective efficacy required specific tasks to be undertaken in group work. Therefore, at the beginning of the semester, pre-service science teachers in the science methods course were assigned to form groups. One of these groups was selected for the case. As the second feature of case study, the selected group was interviewed fourth time in one semester to reveal the participants' thoughts, belief and experiences comprehensively.

The science methods course was designed in parallel to the purpose of the study. In other words, several activities composed in line with the sources of collective efficacy defined by Bandura (1997) were integrated into the course. Each week, one of the nine science teaching methods (i.e., argumentation, field trip, demonstration, role-playing, teaching with analogy, project-based learning, 5E learning cycle, problem-based learning, and laboratory work) was introduced. Before the following lesson, all the groups in the class were asked to work together in order to develop science lesson plans using the related teaching method. Preparing lesson plans as a group during one semester was expected to provide mastery experience for pre-service science teachers. For vicarious experience, every week, upon preparing the lesson plans, each group monitored microteaching performance of other groups. Other groups in the class and the researchers provided feedback what they had seen in the microteaching. Furthermore, every week the groups got feedback about their lesson plans. Thus, this activity was expected to provide the verbal persuasion source. No activity was implemented regarding the physiological and affective state since this source concerns the internal state of a group, such as stress, mood states, arousal, and anxiety. Table 1 shows an outline of the organization of sources of collective efficacy related to activities in the science methods course.

Table 1.
Organization of Sources of Collective Efficacy Related to Activities in the Science Methods Course

Sources of Collective Efficacy	**Activities used in the course**
Mastery Experience	Each group developed their own lesson plans about one teaching method introduced every week.
Vicarious Experience	Each group monitored the performance of other groups or people.
Verbal Persuasion	Each group gave feedback to the other groups about their performance. The course assistants gave feedback about groups' performances.
Physiological and Affective State	No activity.

After the science methods course was developed with the activities related to the sources of collective efficacy, the study was implemented as follows: The course was conducted over four hours in a week. Each week in the first hour of the semester-long course, the professor presented theoretical information about one of the nine science teaching methods. In the following hour, the course assistants gave a sample microteaching session based on the method that had been presented. Then, the groups were given one week to prepare their own lesson plans using the science teaching method they had learned about in the previous week and performed microteachings based on their lesson plans. The groups presented their microteaching in front of the class, and in the last two hours of the weekly course, each group was received feedback on their performance from the other groups and the assistants. This process shown in Figure 1 was applied to each of the nine science teaching methods.

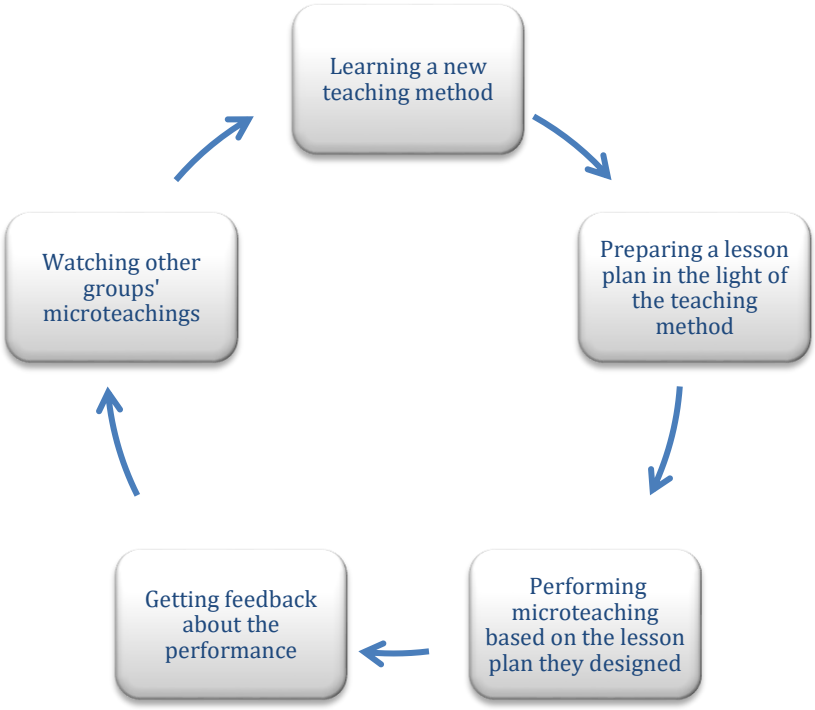

Figure 1. Cycle of each teaching method in the science methods course

2.3. Participants

Four pre-service teachers (two male and two female) working in the same group were selected for the case study. Participation was voluntary to minimize the risk of withdrawal. The grade point average of the selected group ranged from 1.86 to 3.46. The group members were in the 21-24 age range. In the result section, extracts from the interviews of the group members were presented in order to support the findings of study. Taking ethical issues into consideration, the following pseudonyms were used; Jennifer, Stella, John, and Chris.

2.4. Data Collection and Analysis

Group members were interviewed individually four times. At the beginning of the semester, first interviews were conducted in order to get some information regarding preservice teachers' demographic information, attitude toward group work, teaching experience, and science teaching efficacy beliefs. For the rest of interviews, the researchers formed a semi-structured interview protocol. By getting feedback from two experts, the final version of the protocol was developed. Using the same protocol, each group member was interviewed three times after the preparation of the third, sixth, and ninth lesson plans to reveal the changes in the science teaching efficacy beliefs of pre-service teachers over time in the science methods course. All interview questions were prepared based on two main questions: "Do you believe that you can teach science effectively to middle school students?" and "Do you believe that as a teacher you would make students understand science effectively and become successful?". These questions were developed based on two components (PSTE and STOE) of Science Teaching Efficacy Belief Instrument (STEBI) developed by Enochs and Riggs (1990). During second, third and fourth interviews, the same questions were asked again to see the changes and make decision whether there was improvement on participants' PSTE and STOE. All the interview sessions were recorded by a camera. In order to pay attention to ethical issues, each group member was informed that their identity was not going to be revealed and gave consent for video-recording of their interviews.

As for the researchers, their role in qualitative studies is to see the big picture of the research process (Miles & Huberman, 1994). In the current study, the first researcher, one of the course assistants, did not get involved actively in the process of data gathering in order to avoid bias and presenting a threat to the research. The first researcher conducted the interviews to collect data and his role was also to inform the other course assistants about what they would be doing during the remainder of the course. The second researcher was the lecturer of the course who was responsible for presenting the necessary theoretical information for each of the nine teaching methods each week.

Qualitative research methodology was used to analyze data (Merriam, 2009). This analysis process comprised of forming transcriptions, reading them several times, taking notes, preparing a summary sheet, and creating codes and themes. Same repeated idea or thought were named as codes which are related to mastery experience, vicarious experience and verbal experience. These codes were united into two general themes (development of PSTE and development of STOE). In the study, some techniques used in order to provide trustworthiness of data analysis process. For example, a second coder was asked to

do another analysis independently; then, they were negotiated to reach agreement. In this study, the researcher and the second coder reached 97% agreement. This provided credibility by providing more correct evaluation of the findings. Another technique for trustworthiness referred to objectivity of the researchers. For this, direct quotation from answers of the participants was used to elaborate the findings.

3. FINDINGS

3.1. Development of Personal Science Teaching Efficacy (PSTE)

When the group members were asked about their self-efficacy beliefs in science teaching prior to the science methods course, they gave different responses and explanations which showed that one of the participants had higher self-efficacy regarding science teaching than others. More specifically, Stella mentioned that she had some experience about teaching science; thus, she believed in herself about teaching science. She explained this as follows:

> *I can do that [teaching science]. I believe in myself since I have been giving private science lessons to middle school students for a while, and I have received positive comments from them. They said they understood well when I taught the lesson.*

John stated that since they had no experience in teaching science, they did not have enough confidence in science teaching. For example, John responded, *"I do not know. I have no experience about teaching science. Maybe I can teach some science concepts but not all."*

Like John, Chris explained that he did not believe in himself because he did not have sufficient knowledge on science teaching. Chris mentioned: "*It [teaching science] seems difficult for me. Although here [in science education program], I have learned much knowledge about concepts of science in detail, I do not know how to transfer this knowledge on students."*

Jennifer also expressed that she was unsure whether she had the necessary skills to teach science. Jennifer's statement was: "I believe I can teach science but I am not sure I become effective since I do not know to what extent I should teach the concepts of science."

After the initial interview, the course started. As mentioned earlier, during the first three weeks of this course, the group prepared lesson plans for demonstration, 5E learning cycle, and argumentation. At the end of the third week, the participants were asked whether they believed in themselves to teach science effectively to middle school students. Although most group members were not sure at the beginning of the course, they thought that their self-efficacy belief in teaching science had improved compared to their initial level. For example, Jennifer explained this as follows: "*I do not claim that I can teach science effectively because I have not had enough experience yet or I have not had any evidence to prove it. However, I have this belief; therefore, I can do it."* When asked about the reasons behind the development of their thoughts about self-efficacy, they gave different responses related to their experience in group work. For example, Jennifer mentioned that as a group, they used other groups' microteaching plans as models to prepare effective lesson plans, which enhanced her belief in herself about teaching science. This indicates that vicarious experience of collective efficacy had a positive influence on her self-efficacy. In the interview, Jennifer made the following comments:

> *We observed other groups' microteaching and observed some important points about the content of the lesson. We tried to integrate them into our following lesson plans. We also recognized some mistakes in them [microteachings]. We tried to avoid these mistakes. As a result, I think we prepared lesson plans very well. Now, when I need to prepare a lesson plan alone, I will continue to use these important points and not to repeat these mistakes. This made me believe in myself in teaching science.*

John, who had showed low self-efficacy, said that his belief regarding science teaching was improved compared to his situation in prior interview. He added that he benefited from the feedback of the course assistants concerning teaching science. In other words, he emphasized that the verbal persuasion of the course assistants and other groups about their group lesson plans led to the development of his self-efficacy. John stated:

> *I have confidence about teaching science since as a group we prepared lesson plans by considering the smallest detail. Then, we received feedback from the assistants and other groups. They usually referred to what they liked in our lesson plans or microteachings. When we had positive feedback, we wanted to make it even better. Therefore, I think that this is very beneficial since it affected me individually. This helped me gain confidence about myself [in teaching science].*

Similarly, Chris said that they believed more in himself about teaching science based on previous experience. He also mentioned implicitly the influence of verbal or nonverbal feedback from other groups in the classroom; therefore, it can be inferred that verbal persuasion played an important role in enhancing his self-efficacy beliefs. His words are as follows:

The other day I tried to perform the microteaching [based on the lesson plan they prepared together] in front of my peers. I asked some questions related the topic to attract their attention and I saw that I am good at it. So, I gained confidence regarding teaching science.

Stella stated that they learned how to develop lesson plans individually when working as a group every week, and this experience increased their belief in themselves about teaching science. According to their responses, the mastery experience of the group in preparing lesson plans helped them individually to develop their belief regarding teaching science. An excerpt from Stella's interview was given below:

In-group meetings, we discussed many points every week to prepare lesson plans. For example, we considered how the teacher would attract students' attention to the lesson, we argued how the teacher would associate a science concept into real life, or we discussed appropriate activities for a chosen topic and class level. Now, I have confidence in teaching science since I have gained a lot of experience in these meetings.

When compared to their initial statements about self-efficacy at the beginning of the semester, there was improvement about the group members' PSTE after the first three lesson plans. In addition, it was observed that the group members focused on different sources of collective efficacy -mastery experience, vicarious experience, and verbal persuasion- to explain the reason of this development. Table 2 showed the participants' reasons in their improvement of PSTE based on the sources of collective efficacy during first three lesson plans preparation below.

Table 2.
The reasons of improvement in PSTE during first three lesson plans preparation period

	Sources of Collective Efficacy			
	Mastery Experience	**Vicarious Experince**	**Verbal Persuasion**	**Physiological and Affective State**
Jennifer	-	✓	-	-
John	-	-	✓	-
Chris	-	-	✓	-
Stella	✓	-	-	-

Over the following three weeks, the participants prepared three more lesson plans related to fieldtrip, project-based learning, and problem-based learning. After the preparation of a lesson plan for problem-based learning, their PSTE seemed to have improved. For example, Stella explained that with the increase in her self-confidence, she started to think more positively about her ability to teach science to middle school students. Jennifer and John commented that mastering how to prepare lesson plans in a group improved their PSTE. This once again demonstrates the important role of mastery experience of collective efficacy on PSTE. This situation was most clearly seen in the interview of Jennifer:

These lesson plans reinforced my confidence about teaching science because more experience about lesson preparation as a group helped me understand how different parts of a lesson plan should be constituted. For example, I clearly understood how to close a lesson or make an assessment based on the objectives of the lesson when preparing the lesson plans.

Stella's explanation about the reason for her increased PSTE was on the same line as her peer. However, she additionally referred to the contribution of group achievement to her increased belief in herself: "*Our success as a group and the grades we got showed that we prepared effective lesson plans. This increased my self-confidence. I think I can prepare a lesson plan if I follow what we did in group work.*"

Chris mentioned that he observed other groups' microteachings and he would take them as a model in teaching science to his future students. He added that this event led to enhance his PSTE. In other words, his PSTE was improved by the vicarious experience source of collective efficacy. Chris explained his view as follows:

We had a chance to observe other groups' microteachings. They found more creative activities for each teaching method in these lesson plans, and I will implement some of them in my [future] class to attract students' attention. I think this has developed my confidence [about teaching science].

It was clear that their PSTE was enhanced more in the period of the preparation of lesson plans for fieldtrip, project-based learning, and problem-based learning. While three of the group members underlined mastery experience source of collective efficacy in preparing lesson plans as the reason of this improvement, the other group member emphasized that vicarious experience source of collective efficacy made him believe more to teach science effectively. Table 3 demonstrated that the participants' reasons in their improvement of PSTE based on the sources of collective efficacy during the second three lesson plans preparation below.

Table 3.
The reasons of improvement in PSTE during second three lesson plans preparation period

	Sources of Collective Efficacy			
	Mastery Experience	**Vicarious Experince**	**Verbal Persuasion**	**Physiological and Affective State**
Jennifer	✓	-	-	-
John	✓	-	-	-
Chris	-	✓	-	-
Stella	✓	-	-	-

The participants prepared the last three lesson plans on teaching with analogy, role–playing, and laboratory work. In their last interview, all members of the group stated that their PSTE further improved since the previous interview undertaken at week six. For example, Stella expressed her view as follows: *"I believe in myself more because I learned three new teaching methods through our group lesson plans. So, I can teach more science concepts using these methods."*

John, Stella and Jennifer implied that their lesson plan preparation experience in a group every week contributed to the development of their PSTE. John's words were indicated in the following quote:

> *As a group, we tried to prepare much better lesson plans than before. Therefore, we always searched for activities to include in the lesson plans and integrated these activities into the lesson by using teaching methods in each group work. Through the group experience, I also developed my abilities [about teaching methods], as well as preparing lesson plans. So, I gained more confidence about science teaching. I think I can teach effectively now.*

Similarly, Stella emphasized that such group experience about lesson planning helped her increase her confidence in teaching science: *"When preparing the lesson plans, we, as a group, tried to find more creative activities. This experience widened my horizons. I feel like I can teach every science concepts effectively to students."* In parallel to John and Stella's statement, Jennifer expressed that her anxiety decreased as a result of preparing lesson plans with the other members of the group every week: "*Preparing lesson plans as a group reduced my anxiety since I also gained more experience individually about lesson planning."* On the other hand, Chris focused on another source of collective efficacy, verbal persuasion. His self-efficacy belief about teaching science was influenced by verbal feedback of the course assistants on their group lesson plans. Below is an excerpt from his interview:

> *We continued to receive positive feedback about lesson plans from our course assistants even if we made some mistakes. This showed that we were good at preparing lesson plans. This improve my belief [in myself about teaching science]. I can [individually] prepare lesson plans similar to lesson plans we prepared as a group.*

During the preparation of the last three lesson plans, the participants' PSTE were getting better compared to their situation in the preparation of previous three lesson plans. Three of the group members argued that mastery experience source of collective efficacy was an important factor while one group member pointed out that verbal persuasion had an impact on the improvement in PSTE. Table 4 presented the reasons in their improvement of PSTE based on the sources of collective efficacy during last three lesson plans preparation below.

Table 4.
The reasons of improvement in PSTE during last three lesson plans preparation period.

	Sources of Collective Efficacy			
	Mastery Experience	**Vicarious Experince**	**Verbal Persuasion**	**Physiological and Affective State**
Jennifer	✓	-	-	-
John	✓	-	-	-
Chris	-	-	✓	-
Stella	✓	-	-	-

In brief, PSTE of all participants continuously increased during the semester. Their reasons for this development were related to different sources of collective efficacy; mastery experience, vicarious experience, and verbal persuasion. In Table 5, the reasons of participants were presented across three different time intervals. According to the table, it was shown that they mostly pointed out the influence of mastery experience. Moreover, the participants' reasons for the improvement of their PSTE were observed to change over time. For example, Jennifer and John argued that their PSTE was developed with the help of vicarious experience and verbal persuasion in the first three lesson plans respectively. However, they changed the reason as mastery experience after the second three and last three lesson plans. Stella, on the other hand, was consistent and she kept giving same reason (mastery experience) about her development in PSTE. Chris was only one participant who did not mention the effect of mastery experience. Instead, verbal persuasion and vicarious experience were emphasized alternately. In the

scope of the current study, it was seen that although all participants underwent the same implementation, they could give different the sources of collective efficacy as a reason of their PSTE at a specific time.

Table 5.
The participants' reasons of their improvement in PSTE across three different lesson plans preparation periods

	Jennifer			**John**			**Chris**			**Stella**		
	First three lesson plans	**Second three lesson plans**	**Last three lesson plans**	**First three lesson plans**	**Second three lesson plans**	**Last three lesson plans**	**First three lesson plans**	**Second three lesson plans**	**Last three lesson plans**	**First three lesson plans**	**Second three lesson plans**	**Last three lesson plans**
Mastery Experience	-	✓	✓	-	✓	✓	-	-	-	✓	✓	✓
Vicarious Experience	✓	-	-	-	-	-	-	✓	-	-	-	-
Verbal Persuasion	-	-	-	✓	-	-	✓	-	✓	-	-	-
Physiological and Affective State	-	-	-	-	-	-	-	-	-	-	-	-

3.2. Development of Science Teaching Outcome Expectancy (STOE)

In order to elicit their initial views on their STOE, at the beginning of the study, the group members were asked whether they believed that they would support the success of their students in science learning as a teacher. Although all the participants mentioned that they would be competent science teachers when they are inservice, they gave different reasons for this belief. For example, Stella, Chris, and John commented that their teaching experience led to enhance the development of their belief. Stella stated, *"I think I can be an effective teacher. As I mentioned before, I gave private lessons to middle school students. One of these students said, 'I have understood it very well'. This made me believe that I can become a good teacher…."*

Jennifer also believed that she would be beneficial for her potential students to teach science. Supporting her idea, she mentioned the influence of her education about science teaching and explained this as follows:

> *I believe this. I have been learning how to teach science to students [in the science teacher education program], and I have gained experience particularly about the student-centered approach. So, I believe in myself that I can teach science, and my students will learn science well.*

The pre-service teachers' STOE was examined again after they prepared three lesson plans for demonstration, 5E learning cycle, and argumentation. All four stated that they believed in themselves more as a teacher in terms of helping students understand science topics and become successful in this course. Concerning this situation, Stella made the following comments:

> *Now I believe more that I can contribute to my students learning science because we prepared lessons plans like real teachers. I have learned many important things from these lesson plans, which I will try to implement in my future classes.*

Regarding the underlying reason for their beliefs, all group members gave responses that indicated the influence of the mastery experience source of collective efficacy on the improvement of their STOE. More specifically, it was mentioned that as a group, the lesson plans they prepared to help students understand science topics effectively and developed their own STOE. Stella explained her view as follows:

> *In these lesson plans, we always started a lesson with an interesting activity to attract their [students'] attention. I will implement such activities in my future classroom to increase my students' attention so that my students will learn science.*

After the preparation of three more lesson plans, all the group members stated that their belief that they would contribute to their future students' success in science as a teacher was further improved. For example, Stella stated:

> *I definitely believe more that I can contribute to students' learning science because when I consider my middle school science teachers, I realize that they adopted direct instruction. If I compare myself with them, I think that I*

can make a difference to my students' learning science; therefore, my students will become more successful. For example, I can attract students' attention with the methods I have learned or by giving concrete examples for abstract concepts.

When asked about their reason for their belief, the participants mentioned that group experience in preparing lesson plans led them to believe more that their teaching would positively influence their students' learning. In other words, mastery experience helped the group members to improve their STOE. For example, Chris commented:

I definitely believe this because [as a group] we generally considered everything to make students learn easily and extensively discussed whether each activity was appropriate or whether a science topic was taught with the teaching method included in the lesson plans. What we have done in group work helped me learn such topics, as well. I will pay attention to them in my teaching. Thus, I believe in myself more that I can be an effective teacher for my students to learn science.

After preparing the last three lesson plans for teaching with analogy, role-playing, and laboratory work, Chris and Stella once again pointed out that they now believed even more than the last interview that their approach would result in students understanding science effectively. Below is an excerpt from Stella's last interview:

It [My belief] has improved because during the last three weeks, we have learned three more different teaching methods effectively, and all these teaching methods made a positive contribution to me. I will use all of them [when I become an in-service teacher]. I believe that using these teaching methods will be helpful for the success of my students.

Although John and Jennifer also emphasized that their belief was improved, they approached this from a different point of view, stating that they would help students like science and develop positive attitudes toward science, which would in turn result in higher student achievement in science. Jennifer stated:

I believe in myself more since I think I can turn the negative attitude of students toward science into positive. I can motivate them to learn and improve their enthusiasm for learning. I think all of these will positively influence my students' success in learning science.

As a reason for the development of their belief, the participants mentioned again the effect of mastery experience in which they emphasized that they used similar activities or applications in the last three lesson plans to help their students learn science effectively. For example, Jennifer expressed her views as follows:

In group work, we discussed whether students would understand a science topic. For this, we took into consideration the grade level of students. We prepared lesson plans in the light of that. For example, we simplified information or we tried to give examples from daily life. I am planning to consider all of these in my teaching to increase the success of my students.

In brief, all the group members believed that they would be more effective in helping student learn science. Moreover, they reported that their STOE was continuously enhanced during the semester, and the mastery experience source of collective efficacy is major source in the development of their belief.

4. RESULTS, DISCUSSION AND RECOMMENDATIONS

Considering the findings of the study, it was pointed out that the sources of collective efficacy played a determinative role in the development of the group members' science teaching efficacy beliefs. This is justified by other studies in the literature that reported collective efficacy was significantly associated with the self-efficacy of group members (Fernandez-Ballesteros et al., 2002; Fives and Looney, 2009; Goddard and Goddard, 2001; Lent et al., 2006; Lev and Koslowsky, 2009; Skaalvik and Skaalvik, 2010; Viel-Ruma et al., 2010). Contrarily, the group members never directly mentioned the effect of collective efficacy when addressing the sources of collective efficacy as responsible factors in the improvement of their PSTE and STOE. This can be explained again by Junqueira and Matoti's (2013) claim that interpretation of experience shapes efficacy information. Therefore, all the group members provided reasons for the improvement of their PSTE and STOE based on their experiences in group work.

Regarding PSTE, the group members continuously improved their belief that they could teach science effectively. In addition, the group members gave different reasons for this development, referring to the influence of mastery experience, vicarious experience, and verbal persuasion individually. These differences can be attributed to personal perception. Moreover, the positive contribution of the mastery experience source of collective efficacy was particularly emphasized by the group members. This is congruent with Bandura's (1997) and Palmer's (2006) notion that mastery experience was the most critical effect on science teaching efficacy. Moreover, it was noted that the pre-service teachers altered their reason for the

improvement of their PSTE over time. This may be because the sources of collective efficacy do not have the same influence on the development of pre-service teachers' PSTE at a specific time.

Concerning STOE, the group members believed that they would be effective in helping students become successful in science. Moreover, the group members' STOE was continuously enhanced, and preparing lesson plans as a group every week had an impact on the improvement of their belief. This finding is again complying with Bandura's (1997) and Palmer's (2006) studies showing the power of mastery experience. One possible reason why mastery experience of collective efficacy was a major responsible factor in improving STOE may be related to the perception of group members. Concerning this issue, the participants stated that when preparing lesson plans as a group, they considered important points, such as the grade level of students and their interest. These may be individually perceived as important for students' learning science effectively; therefore, by this process, the pre-service teachers also improved their own individual belief that these points would contribute to their becoming effective science teachers.

Collective efficacy seemed to influence the pre-service teachers' science teaching efficacy beliefs. Therefore, science teacher educators might consider the collective efficacy when designing their courses in order to improve pre-service teachers' self-efficacy regarding teaching science. For this purpose, the sources of collective efficacy can be integrated in the courses in teacher education programs. Especially, when the powerfulness of mastery experience is considered, increase in group work practices in the flow of courses can be meaningful. On the other hand, activities including observing other groups' works and giving feedback might strengthen development of collective efficacy in the classroom.

Considering the importance of collective efficacy, its relationship with other variables might be examined in science education. For example, research has shown that collective efficacy is significantly linked to group performance (e.g., Bandura, 1997; Goddard, 2001; Greenlees, Graydon, and Maynard, 1999; Gully, Beaubien, Incalcaterra, and Joshi, 2002; Hasan and Ali, 2007; Klassen and Krawchuk, 2009; Peterson et al., 2000; Wang et al., 2014), the nature of this relationship has hardly been investigated. Therefore, an in-depth investigation into the characteristics of the relationship between collective efficacy and group performance in teaching and learning science would contribute to the related literature.

There are some limitations in this study. First, it was conducted at one-long semester. This duration may be considered as insufficient to observe the influence of collective efficacy on science teaching efficacy beliefs when the difficulty of changing beliefs was taken into account. Therefore, longitudinal studies can be more beneficial to explain the relationship of these two constructs. Moreover, this study was limited to nine science teaching methods. Although they generally stated that their science teaching efficacy beliefs was developed, it is uncertain how their group work and their beliefs are affected when they face new challenging teaching methods in time.

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Research and Publication Ethics Statement

Ethical issues were taken into consideration in the study. Before it was conducted, the research was approved by ethical community of the institution in which the authors would collect data. In addition, during the research, it was paid attention that there was no physical or psychological harm for the participants. They also were assured that the research data would be kept in confidence.

Contribution Rates of Authors to the Article

This study was a part of the first author' dissertation. Therefore, he participated in every part of the research such as data collection, data analysis and writing this document. The second author, the supervisor of the first author, help him to give feedback about the process. For example, she took charge in preparing data collection tools, controlling the analysis of data and checking the document in terms of grammar, clarity and language.

Statement of Interest

There is no conflict of interest in the study.

6. GENİŞ ÖZET

Öğretmen adaylarının eğitiminde grup çalışması daha iyi öğrenme çıktıları elde etmek için uygulanan tekniklerden biridir. Olumlu katkıları olmasına rağmen, her grup çalışmasının etkili sonuçlar vermediğini birçok faktörün grup çalışmasında önemli rol oynadığı görülmüştür. Bir grubun belirli düzeyde başarı elde edebilmek için gerekli olan eylem aşamalarını düzenleme ve yönetme yeteneklerine ilişkin paylaştıkları ortak inançlar olarak tarif edilen kolektif yeterlik, grup çalışmasının işleyişini etkileyen faktörlerden biri olarak gösterilmektedir. Kolektif yeterlik, dört ana kaynaktan beslenmektedir. Bunlardan ilki, doğrudan yaşantıdır. Grubun bir amaç doğrultusunda gerçekleştirdiği deneyimler olarak açıklanmaktadır. Dolaylı yaşantı kaynağı ise diğer grupların veya insanların gerçekleştirdikleri deneyimlerini model almak ve onları kendi performanslarına kullanmaktır. Sözel ikna, diğer kolektif yeterlik kaynaklarından biridir. Grubun performansına yapılan olumlu geri dönütlerin grubun ileri performansını katkıda bulunduğu görüşünü içermektedir. Son olarak, grubun içinde bulunduğu psikolojik ve duygusal durumların grubun yeterlik inancını etkilediği düşünülmektedir.

Fen öğretimine yönelik öz yeterlik inançları, öğretmenlerin sınıf içi tutum ve davranışlarını etkileyen en önemli belirleyicilerden biridir. Yüksek düzeyde öz yeterliğe sahip öğretmenlerin sınıf içinde daha fazla zaman geçirdikleri, fene karşı olumlu tutum geliştirdikleri, öğrenci merkezli öğretim stratejileri kullandıkları ve sınıf yönetiminde hümanist bir yaklaşım benimsedikleri görülmüştür. Fen öğretimine yönelik öz yeterlik inançlarının, fen öğretim yeterliği ve sonuç beklentisi olmak üzere iki bileşeni vardır. Fen öğretim yeterliği, feni etkin bir şekilde öğretebilme inancı, sonuç beklentisi ise fen öğretiminin öğrencide olumlu sonuçlara yol açacağı inancı olarak açıklanmaktadır.

Kolektif yeterliğin birçok değişkenle ilişkisi olduğu saptanmıştır. Özellikle, kolektif yeterliğin, grup performansı ve öz yeterlikle ilişkisi geniş ölçüde araştırma konusu olmuştur. Diğer yandan, öğretmen adaylarını kolektif yeterlik açısından inceleyen çalışmalar oldukça sınırlı sayıdadır. Bu çalışmalar da kolektif yeterliğin zaman içinde geliştiğini, grup tartışmalarında ve grup performansında önemli bir rol oynadığını göstermiştir Bununla beraber, hala alanyazında, öz yeterliğe nasıl etki yaptığı yönünde eksiklikler vardır.

Bu çalışmanın amacı, özel öğretim yöntemleri dersinde fen bilgisi öğretmen adaylarının kolektif yeterliğinin öz yeterliğe olan etkisini incelemektir. Çalışmada nitel araştırma yöntemlerinden durum çalışması kullanılmıştır. Özel öğretim yöntemleri dersinin gereklerini yapmak üzere oluşturulan gruplardan biri durum olarak seçilmiştir. Seçilen bu grup, bir dönem boyunca incelenmiş, belirtilen amaç doğrultusunda veri toplanmıştır. Özel öğretim yöntemleri dersinde, öğretmen adaylarının yeni fen öğretim metotlarını öğrenmelerini sağlamak temel amaçtır. Bu bağlamda, fen bilgisi öğretmen adaylarına her hafta yeni bir

fen öğretim metodu anlatılmış, bu metotlar çerçevesinde ders planları ve ders anlatımları yapmaları beklenmiştir. Bu çalışmada; dönem başında katılımcılarla ile ilgili demografik bilgilere ulaşmak, geçmişte yapmış oldukları grup çalışmaları hakkında bilgi edinmek ve fen öğretimine yönelik öz yeterlik düzeylerini öğrenmek için ön görüşme yapılmıştır. Süreç boyunca her üç haftada bir katılımcılarla görüşmeler yapılarak araştırmanın amacı doğrultusunda veri elde edilmiştir. Toplanan nitel veriler önce yazıya dökülmüş, verilerde kodlama yapılmıştır. İlgili kodlar aynı tema altında birleştirilmiştir. Bu çalışmacının sonucu olarak, kolektif yeterlik kaynaklarının grup üyelerinin fen öğretim yeterliğinin ve sonuç beklentilerinin gelişiminde önemli rol oynadığı bulunmuştur. Grup üyeleri, kolektif yeterlikten doğrudan bahsetmek yerine, kolektif yeterlik kaynaklarının fen öğretim yeterliğinin ve sonuç beklentilerin gelişiminde etkili olduğunu dile getirmiştir. Katılımcılar feni etkili bir şekilde öğretecekleri inancının süreç boyunca arttığını dile getirmişlerdir. Birbirlerinden bağımsız olarak doğrudan yaşantı, dolaylı yaşantı ve sözel ikna olan kolektif yeterlik kaynaklarını bu gelişimin sebebi olarak vermişlerdir. Ayrıca, grup üyelerinin fen öğretim yeterliğinin gelişiminde sebep olarak verdikleri bu kaynakları zamanla değiştirdiği görülmüştür. Bu durumun sebebi, fen öğretim yeterliğin gelişiminde kolektif yeterlik kaynaklarının belli bir zaman diliminde eşit bir şekilde rol oynamaması olarak düşünülmektedir. Sonuç beklentisinde ise, grup üyeleri öğrencilerinin fen de başarılı olmasını sağlayacaklarına inandıklarını belirtmişlerdir. Bu inançları sürekli olarak artmıştır. Bu artışın sebebi olarak bütün grup üyeleri doğrudan yaşantıdan bahsetmişlerdir. Grup üyelerinin sonuç beklentisinin gelişiminde sürekli olarak doğrudan yaşantıyı sebep olarak vermesi, grup üyelerinin sürekli öğrenci açısından düşünmesi ve bu yönde dersi planlaması ile açıklanabilir. Bu çalışmadan elde edilen bulgular ışığında fen öğretmen eğitimcilerine bazı önerilerde bulunulmuştur. Öncelikle, kolektif yeterliğin grubun üyelerinin öz yeterlik inançlarına olumlu bir etki yarattığından, fen öğretmen eğitimcilerinden derslerini kolektif yeterliği oluşturmaya göre dizayn etmelidirler. Çalışmanın bulgusu olan kolektif yeterliğin oluşumunu sağlayan dört önemli kaynağın öğretmen eğitim programlarındaki derslere entegre edilmesi gerekmektedir. Doğrudan yaşantı için fen öğretmen adaylarından birçok kez grup ile beraber ders planları yapmaları istenmelidir. Grupların, diğer grupların yaptığı ders anlatımlarını incelemesine izin verilmesi de dolaylı yaşantı için yapılacak bir etkinlik örneğidir. Ayrıca; kolektif yeterliğin, sözel ikna kaynağı için gruplara ders anlatımı veya ders planları için geri dönüt verilerek artıları ve eksileri anlatılmadır. Son olarak, kolektif yeterlik kaynağı olan psikolojik ve duygusal durumlar için ise stresten, korkudan ve endişeden uzak bir ortamda grupların çalışılması sağlanmalıdır. Fen öğretmen eğitimcileri, bu tür önerileri sadece fen öğretim metotları dersinde değil, programda yer alan diğer derslerde de dikkate almalıdırlar.