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The Effects of Using Peer-Led Team Learning Model in Science Courses on Students*

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Abstract

This study aims to explore the views of the fourth-year pre-service science teachers and science education master's program students regarding the effects of using the Peer-Led Team Learning (PLTL) model in science courses on the students. A total of 56 participants—28 undergraduates and 28 graduate students—participated. The Views About the PLTL Model A questionnaire and a semi-structured interview form were used as data collection tools. Content analysis was used during the data analysis. The results suggested that the PLTL model has positive and negative effects on peer and leader students in terms of "learning", "motivation/attitude" and "skills". The number of participants emphasizing positive effects in both questionnaire and interview data was much higher than those referring to negative effects. In other words, more participants agreed on the positive effects. When the possible positive and negative effects of the PLTL model were evaluated, the positive effects were identified as valuable for the education process, and the negative effects may be eliminated or minimized.

Keywords: Peer-led team learning model, PLTL, Science education

Introduction

An ongoing interest in science and technology has required the adaptation of countries to the developments and innovations. This is possible by harnessing countries' education systems and following scientific as well as technological innovations around the world (Değerli, 2021). Therefore, science education becomes effective in raising individuals who meet the needs of the age since changes and developments in science and technology constantly affect education, which, in turn, contributes to scientific and technological advances (Selvi & Yıldırım, 2017). Ayas (1995) noted that one cannot underestimate the significance of science in the development of countries; therefore, some practices are conducted to improve the curricula to promote the quality of science education and provide opportunities for the implementation of these curricula. In Turkey, considerable steps have been taken in terms of improving the science curriculum, especially since the early 2000s (Ministry of National Education [MoNE], 2006; MoNE, 2013; MoNE, 2018). The Science Curriculum published in 2018 and in force today reports that individuals should possess some qualifications such as producing knowledge, using it functionally in life, solving problems, thinking critically, having communication skills, empathizing, contributing to society and culture, etc. Besides, the curriculum points out the necessity of students' active performance, which further leads to the use of active learning methods in teaching practices (MoNE, 2018). The studies revealed that active teaching methods are more effective than classical methods (teacher-centered methods) at cognitive (Akkurt, 2010), affective (Akpınar et al., 2016), and psychomotor (Birgili, 2022) levels.

The active learning process involves avoiding the teacher's monotonous instruction, monitoring students' progress instead of rewarding or punishing them with grades, providing guidance in case they encounter a problem, and encouraging them to make their own decisions instead of teacher-centered decisions; in short, actions such as hearing, seeing, asking relevant questions, and exchanging opinions are carried out to ensure active learning (Kıyıcı, 2004). Since permanent learning can be honed through practice, there is a need for environments where students can use their knowledge and minds. Hence, teachers acutely prefer active teaching methods that stimulate students to gain high-level cognitive skills such as analyzing and evaluating (Şimşek &

* This study was derived from the first author's master's thesis.

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Yeşiloğlu, 2014). Even though its foundations date back to ancient times, peer tutoring describes the active learning process that has come into prominence in recent years, especially when the significance of student-centered methods has been emphasized.

Peer tutoring is defined as a model for all students to take an active role and to improve communication skills in crowded classrooms where they ensure interactions with peers on group tasks (Şimşek & Yeşiloğlu, 2014). In addition, researchers stated that the teacher can get feedback from all students at the same time, get information about the learning situation of the class, not waste time, and make an efficient application because it is not tiring (Şimşek & Yeşiloğlu, 2014). Peer instruction includes techniques in which peers evaluate and support each other and provide feedback to increase student academic achievement and make a lasting change in behaviors (Gülçek, 2015). Olmscheid (1999) pinpointed that peer tutoring has the potential to provide success for students of all ages and ability levels, regardless of factors outside the school (cultural background, socioeconomic status, or race). Töman and Yarımkaya (2018) concluded that peer tutoring allows students to support one another, to share practices, to take an active role in the feedback process, and to reinforce the instruction process together. Studies conducted on various disciplines put forward the idea that peer tutoring increases student achievement (Eryılmaz, 2004; Kurt, 2020; Nobel, 2005; Öncül, 2020; Özcan, 2017; Sencar-Tokgöz, 2007; Tao, 1999).

Peer-Led Team Learning (PLTL) model is one of the methods by which peers facilitate group learning. The PLTL model highlights that selected and trained peer leaders mediate group work processes in weekly meetings with the aim of discovering solutions to previously introduced problems (Gosser et al., 2010). In this model, students who have previously completed the theoretical part of the course are peer leaders. Thus, in this model, there is a process in which peer leaders and students interact with each other by conducting activities such as debate, discussion, and problem-solving in peer student groups under the guidance of peer leaders (Gosser et al., 2010). As seen in many studies in the literature (Eren-Şişman et al., 2018, Lewis, 2011, Wells, 2012), peer studies in this model start after the theoretical lessons. The teaching methods and routine used by the teacher in the teaching process are preserved since peer leaders get involved after the theoretical part of the lesson. The components (teacher's responsibilities) that are critical for the PLTL model are leader selection, training and continuous supervision, appropriate materials, and an appropriate setting (duration and room) (Gafney & Varma-Nelson, 2008). In this sense, leaders are selected among students who are successful and who have good communication and leadership skills. Since successful leaders must have more than content knowledge, they receive good and careful training for the role they take on. The peer leader does not answer the questions or act as a substitute teacher during the lesson but facilitates the group (Varma-Nelson, 2006). Peer leaders encourage their peers to interact with one another, share their thoughts and discussions, and provide solutions to problems (Gosser et al., 2001).

Current literature includes numerous studies emphasizing that the PLTL model increased students' achievement in science subjects (Drane et al., 2014; Eren-Şişman et al., 2018; Gosser et al., 2010; Hockings et al., 2008; Tenney & Houck, 2003; Tien et al., 2002; Tuzlukaya et al., 2022; Wilson & Varma-Nelson, 2021). Besides, the studies carried out to acquire and develop the 21st century skills, which are the greatest needs of our age, have revealed that the PLTL model helps students develop their communication skills (Erişmiş, 2017), problem solving, teamwork, personal skills (Chase et al., 2020), and critical thinking (Quitadamo et al., 2009). Some studies have also suggested that the PLTL model positively affects affective characteristics in science instruction (Hockings et al., 2008; Tienet et al., 2002; Tuzlukaya et al., 2022). However, it may be wise to mention that these studies have been mostly carried out at the university level. There is a dearth of studies conducted at the primary, middle, or high school levels (Ahmed & Haji, 2022; Lamina, 2021; Njoku, 2020; Okeya, 2022; Wells, 2012). The views of the teachers and pre-service teachers on the implementation are significant in terms of analyzing the model in science subjects at the middle school level. In this study, the views of the undergraduate and graduate students (pre-service science teachers and science teachers) regarding the effects of the model on students with reference to the implementation of the model in middle school science courses were investigated.

In this direction, the aim of this study is to investigate the views of the fourth-year pre-service science teachers and Science Education Master's Program students regarding the possible effects of using the PLTL model in science courses on the students.

Research questions are determined as follows:
1- What are the views of the fourth-year pre-service science teachers and science education master's program students regarding the effects of the PLTL model on peer students?

2- What are the views of the fourth-year pre-service science teachers and science education master's program students regarding the effects of the PLTL model on peer leaders?

Method

The case study, which is a qualitative research design and includes an in-depth explanation and analysis of a limited system (Merriam, 2015), was used in this study. The reason for using the case study design is that the participants of this study were from a single university, and it was planned to conduct in-depth research through different data collection tools. Accordingly, in this study, the views of undergraduate and graduate students enrolled in a state university in Turkey on the effects of using the PLTL model in science courses on students were examined. A questionnaire was applied to all students who voluntarily participated in the study, and then interviews were conducted with the students determined to provide maximum diversity.

Participants

The participants consisted of 28 fourth-year students enrolled in the Science Teaching Program at a state university in Turkey and 28 graduate students learning at the Science Education Master's Program with Thesis. The reason for including graduate and undergraduate students in the research is to ensure that the diversity of data is as large as possible. In addition, the presence of science teachers registered in the master's program is another factor that enriches the diversity of the data. Among the participants, 50 are female and six are male. Eighteen of the participants with a master's degree have professional experience. Table 1 showed details regarding the participants' professional experience and type of institution.

Table 1. Distribution of the participants' professional experience and type of institution

Institution	1-5 years	6-10 years	10-15 years
Middle school affiliated with MoNE	3	5	1
Private school	6	0	0
Training center	2	0	0
Unspecified	1	0	0
Total	12	5	1

As seen in Table 1, three of the students have 1-5 years of experience, five 6-10 years of experience, and one 10-15 years of experience in a public school. Six of them have 1-5 years of experience in a private school, and two of them have 1-5 years of experience in a training center. One student has not specified the type of institution.

Data Collection Tools

The data was collected using the Views About the PLTL Model Questionnaire and a semi-structured interview form. This study is part of extensive research. For this reason, the data collection tools used in this research are more comprehensive than the research questions in this study.

Views about the PLTL Model Questionnaire

This form was developed by the researcher by considering the views and suggestions of six experts (two of them are academicians specialized in science education; one academician who graduated from the Science Education Program and has a master's and doctorate degree in educational sciences; one doctoral student working as a science teacher in a school affiliated with the Ministry of Education; and two are science teachers working in a school affiliated with the Ministry of National Education). The pilot study was conducted with four volunteers. The form got its final version with two parts, including personal information and 12 open-ended questions. Then, all participants responded to the questionnaire. Examples of questions in the questionnaire are as follows: (*i*) Do you use the peer-led team learning model in your lessons? Explain the reason for your answer? (*ii*) Is the peer-led team learning model suitable for students at all grade levels? Explain the reason for your answer. (*iii*) Evaluate the implementation phase of a course in which the peer-led team learning model will be used.

Semi-Structured Interview Form

This form was developed by the researchers by taking into account the data collected from the Views about the PLTL Model Questionnaire. The interview form was structured with the views and suggestions of four experts (two of them are academicians specialized in science education, one academician who graduated from the Science Education Program and has a master's and doctorate degree in educational sciences, and one is a science teacher working in a school affiliated with the Ministry of Education). This form contains 11 questions. Some of these questions are very similar to the questions in the questionnaire, some are the same, and some are completely different. In addition, in order to access detailed and in-depth data, sub-questions have been created for 10 of the questions in this form. Two examples of questions from the interview form are as follows:

Example Question 1:
Evaluate the implementation phase of a course in which the peer-led team learning model will be used.

- Is it possible that there may be problems during the implementation phase?
    - What precautions can the teacher take regarding problems that may occur during the implementation process?
- Does the implementation phase have advantages compared to other teaching models?
- Does the implementation phase have any disadvantages compared to other teaching models?
    - (If the answer is 'yes') what can be done to eliminate the disadvantages?

Example Question 2:
Is the peer-led team learning model suitable for students of all achievement levels?

- Evaluate the work of students of different achievement levels in the same group.
- Evaluate the use of the model in classrooms with high and low achievement levels.

A pilot study was conducted with two volunteer participants. Afterwards, the interviews were held with 14 participants who were determined heterogeneously (e.g., student, teacher, male, female) to ensure the maximum data variety. In this sense, five of the participants are Science Education Program fourth-year students (three female and two male), and nine of them are Science Education Master's Program students (six female and three male). Three of the graduate students have experience in public institutions affiliated with the Ministry of National Education, one in a private school, and one in a training center.

Research Process

The researchers held an information meeting on the PLTL model in which undergraduate and graduate students participated via the Microsoft Teams platform. The participants were informed about the model; however, no details were given about the positive or negative effects of the model on the educational process. Then, the researchers presented two sample lesson plans prepared by adapting the PLTL model to the middle school level. These two lesson plans were prepared on the subject of "Full Shadow", one of the physics subjects, in accordance with the science lesson objectives. Six experts' views (two physics education expert academicians, one science education expert academician, one science teacher with a doctorate degree in science education, and two science teachers) were received during the development process of the lesson plans. Following the presentation, which included the details of the model and sample lesson plans, the participants completed the Views about the PLTL Model Questionnaire via Google Forms. Interviews were conducted via the Zoom platform and lasted about 50-60 minutes on average. The interviews were recorded with the permission of the participants and completed within a week.

Data Analysis

Content analysis was used during the data analysis. The interviews were transcribed by the researcher. During the data analysis, a table format was generated for each positive and negative effect recorded according to this table format, and codes were identified. The tables were filled in separately for the effects of the model on peer students and leader students.

The codes were generated in a way that best reflects the current situation as much as possible, namely, as they are. For instance, a participant thought that the model would increase motivation, attitude, and interest as a positive effect; therefore, these three concepts were coded separately even though they were related to one another. Because there were also other participants who mentioned only one or two of them. Similar codes were classified, and categories were generated. The codes were classified under four categories: "learning", "motivation/attitude", "skill" and "other". The codes in the other category were excluded from the

scope of this study since they were associated with at least one of the categories of learning, motivation/attitude, and skill, yet they were not clearly differentiated from which category they belonged to or may be included in more than one of them, and their frequencies were low. The descriptions of the categories are as follows:

Learning: Codes related to learning such as learning speed, easy learning, learning level, and learning quality.

Motivation/Attitude: Codes related to motivation/attitude such as motivation, attention, interest, curiosity, class participation, and attitude.

Skill: Codes related to skills such as communication, problem solving, critical thinking, and scientific process.

Two researchers worked in coordination, and agreement on the data was achieved during the interview data analysis process. The coding of the questionnaire data was as follows: One of the researchers coded the questionnaire data. Approximately 30% of the questionnaire data were also coded by the other researcher, and the inter-coder agreement rate was found to be 90.68% through the "consensus"/"consensus+disagreement" formula (Miles and Huberman 1994). Thus, the analyses are considered reliable in the present study.

While findings were presented, undergraduate students who participated in the questionnaire were coded as QUGS1, QUGS2, etc.; undergraduate students who participated in the interviews were coded as IUGS1, IUGS2, etc.; graduate students participating in the questionnaire were named as QGS1, QGS2, etc.; graduate students participating in the interviews were coded as IGS1, IGS2.

Findings

The findings of the research are presented in the following sub-headings according to the research questions: All findings obtained from the questionnaire and interview data are displayed in the same figure.

Findings on the First Research Question

The first research question of the study is "What are the views of the fourth-year pre-service science teachers and science education master's program students regarding the effects of the PLTL model on peer students?". The details of the findings related to this question are displayed in the following sub-headings:

"Learning" Category

This category includes 30 codes, 15 of which are positive and 15 are negative. To serve as an example, Figure 1 depicts the emerging codes with the highest number of participants and those with a small number of participants as they were for a special student group (unsuccessful, shy, etc.), the frequency of the codes (f), and the number of participants (n).

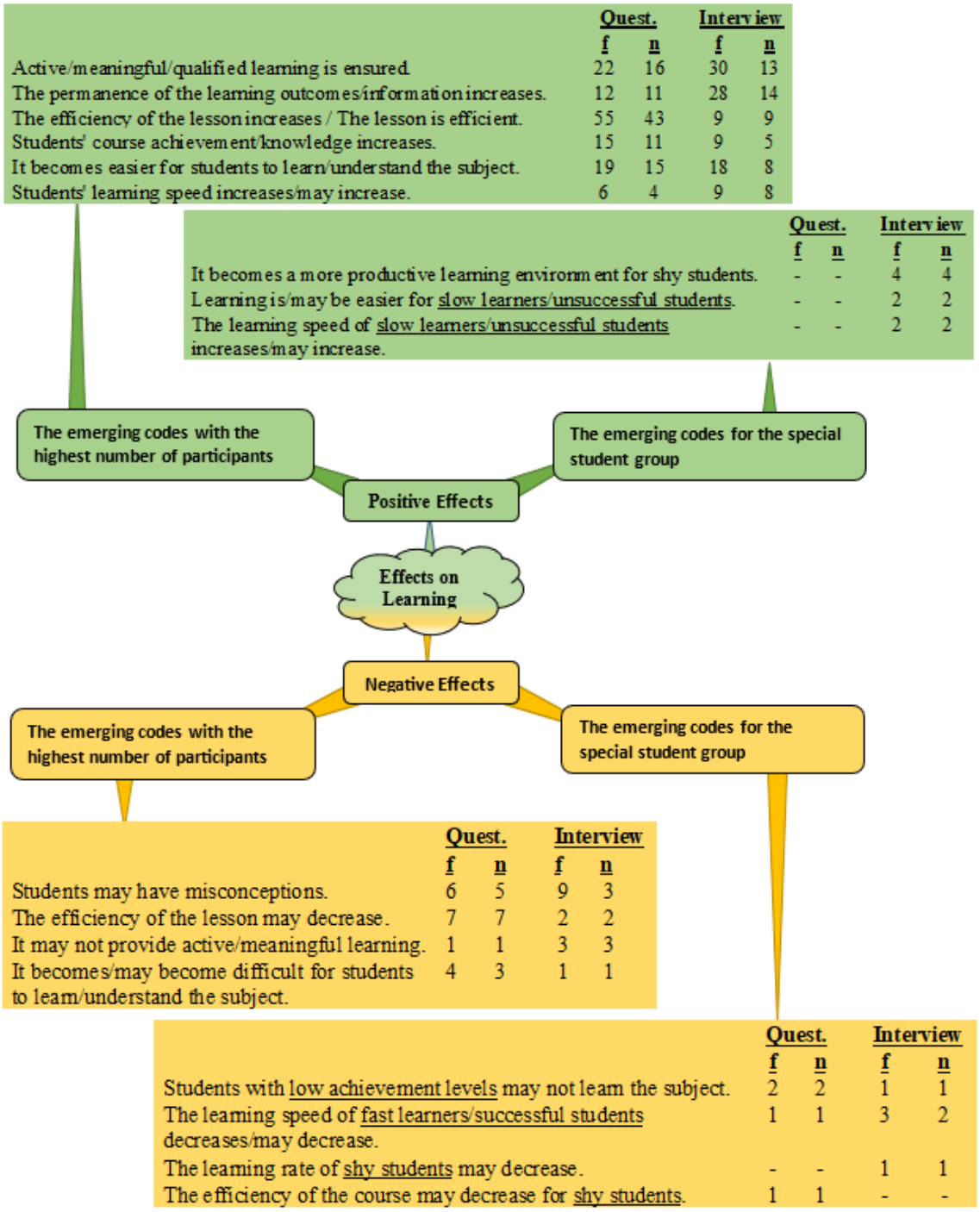

Figure 1. The emerging code samples in the "Learning" category

Figure 1 demonstrates that the number of participants stating positive effects in both the questionnaire and interview data was much higher than that of those stating negative ones. Therefore, more participants agree on the positive effects. Figure 1 also suggests that the first four positive effects were related to the level and quality of learning. Moreover, these four effects were highly interrelated. For instance, the responses of IGS9 relevant to the first three views are as follows: The participant responded to the question, *"Will you use the model in your lessons?"* with the following statement: *"So I use it. I use peer tutoring as it provides more development in students, deepens their learning with their friends and leaders, and makes it more permanent…"* As regards the part of the interview where the participant commented on meaningful learning, *"I think their meaningful learning may increase, teacher. Well. As it will provide deepening, they can make more sense of the subjects together with their peers"*, and in the part on the efficiency of the lesson, *"…I think it can be an efficient model when used correctly"*. As for the questionnaire data on the emerging code

of "the retention of the learning outcomes/knowledge increases", QUGS19 responded to the question "*Evaluate the team learning model in Peer Leadership in terms of measurement and evaluation."* as follows: *"The measurement and evaluation with different activities is effective in making the knowledge more permanent for the students."*

Figure 1 shows that the positive effects of "learning or understanding the subject becomes easier" and "students' learning speed increases or may increase" are related to learning speed or easy learning. As an example of the questionnaire data related to "It becomes easier for students to learn or understand the subject," QUGS12 responded to the question "*Do you use the peer-led team learning model in your lessons?"* with such words as "*Of course I use it... peer-led team learning facilitates learning as it depends on interaction."* In relation to the interview data, this finding was determined in three different parts of the interview, with IUGS3 indicating the advantages of the PLTL model as *"...the topics are easier to learn and become permanent"*, commenting on the retention of the learning outcomes, *"We will remember this more because learning will be easier, and we can use this information anywhere."*. In the later parts of the interview, the participant stated that the students would be willing to use the model and added the sentence *"...most students can learn more easily by communicating with their friends".*

This category also involves some effects on students with certain characteristics. In this regard, various positive effects were reported in the following expressions: "the learning of slow learners or unsuccessful students may be facilitated, their learning speed may increase, and a more productive learning environment may be created for shy students". Some of the views on the negative effects were determined as follows: students with low achievement levels may not learn the subject, and the learning speed of fast learners, successful students, and shy students may decrease. IUGS5 mentioned that the learning speed of successful students may decrease, and this may be because fast learners should wait for slow learners. On the other hand, IUGS2 emphasized that the learning speed of shy students might decrease, as there is a small possibility that shy students may be more hesitant.

The finding that was not mentioned in Figure 1 suggested that some of the participants put forward conditions for some of these effects. To exemplify, QGS12 stated that "active, meaningful, and qualified learning is ensured". The participant also answered the question *"evaluate the implementation phase of a lesson in which the peer-led team learning model is used"* as *"I think an active learning environment will be created if the process is well managed..."* At that point, this participant suggested that the process be well managed as a condition for an active learning environment. The conditions put forward for positive effects in this category (if the process is well managed, if the leader really has leadership qualities, etc.) already should be fulfilled on the basis of the model. This is valid for the negative effects, including the condition. To illustrate, IGS5 defined a negative effect as "Students may have misconceptions" and mentioned the disadvantages of the model during the interview process: *"...if the teacher cannot manage this process well, there may be misconceptions as the teacher cannot manage the class well".* The other conditions stated by the participants for adverse effects were noted as: "If the leaders do not take responsibility, if the leader is chosen incorrectly, if the teacher does not give feedback or correction, if the teacher organizes the groups incorrectly, if the leader has a misconception". Considering the conditions put forward for the negative effects, theese conditions were determined to be those that the teacher already must bring under control so that the model can be applied reliably.

The findings also revealed negative effects, which are the opposite of some positive effects, and these effects were often related to a condition. Most of the participants who were found to have the effect of "the efficiency of the lesson may decrease", which is the opposite of the effect of "the efficiency of the lesson increases", the most frequently emerging codes in the questionnaire data, underlined some conditions such as "if the students are reluctant, if the same model is used all the time, if the leaders are chosen incorrectly, if the teacher does not give feedback or correction".

While details were provided for other categories below, the condition proposed for positive effects was not detailed as it was at the core of the model. On the contrary, examples of the conditional sentences specified for the negative effects are presented, as it is thought to guide the trainers in minimizing or eliminating the negative effects.

"Motivation/Attitude" Category

37 codes, 24 positive and 13 negative, were identified in this category. Figure 2 summarizes the emerging codes with the highest number of participants and those for the special student group: the frequency of the codes (f) and the number of participants (n).

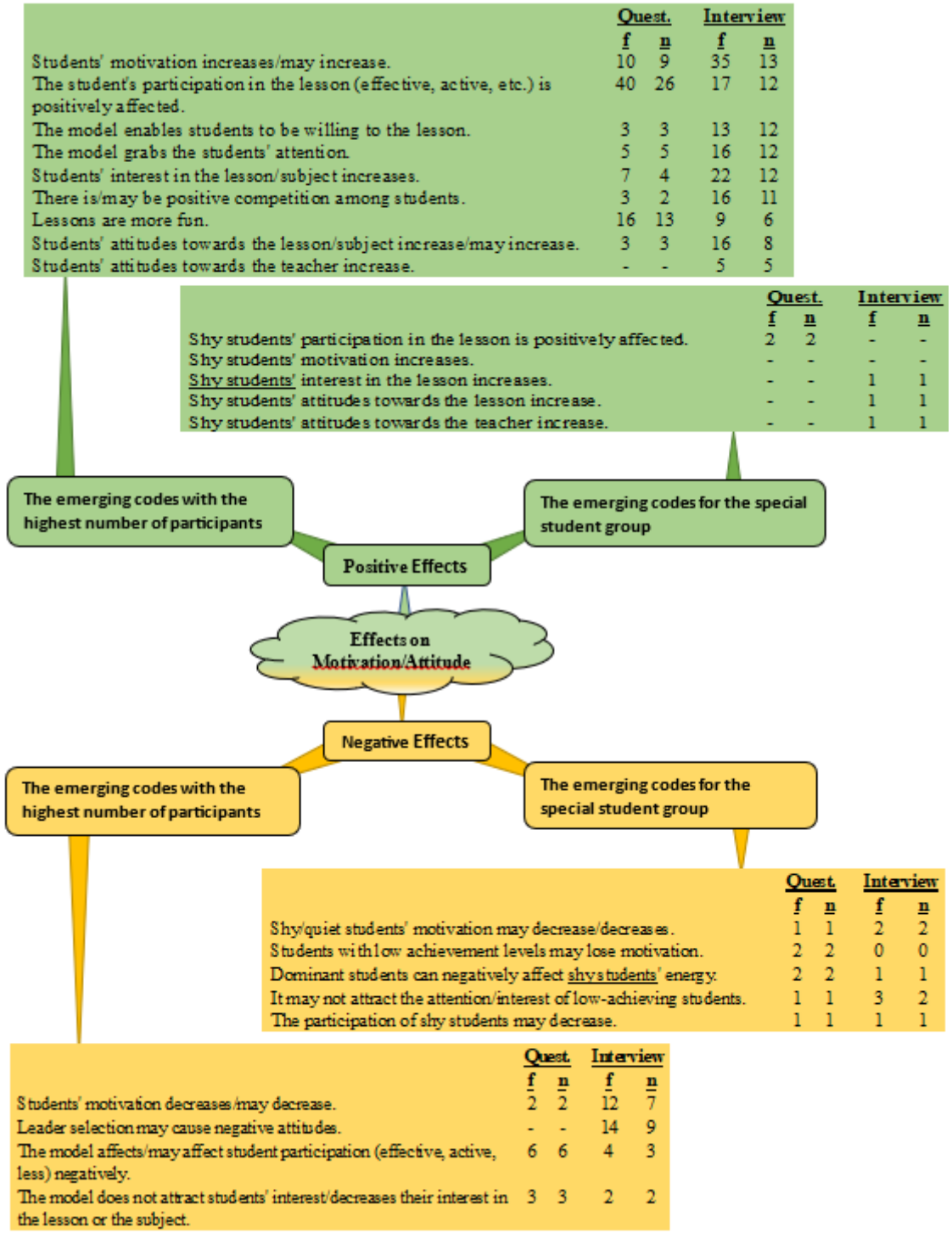

Figure 2. The emerging code samples in the "Motivation/Attitude" category

Upon analyzing Figure 2 in general, the number of participants with positive effects in the questionnaire and interview data was found to be higher than the negative ones. Therefore, more participants agree on the positive effects.

Some participants expressed their views by using the words motivation or attitude, while others expressed their opinions on concepts related to motivation or attitude such as interest, attention, and desire. As in Figure 2, the positive effects that most participants agreed on were that the students' motivation may

increase, their participation in the lesson will be positively affected, and the lessons will be more enjoyable. As for the negative effects, the participants particularly emphasized that the students' motivation may decrease, the choice of the leader may cause a negative attitude, and the student's participation may be negatively affected. Some of these positive and negative effects were opposite each other. For example, the results of the interview data suggested the positive effect of "students' motivation will increase or may increase" and the negative effect of "students' motivation decreases or may decrease" with the highest number of participants. However, all the participants announced that this negative effect could be experienced with conditions such as "if the friends they do not like are chosen as leaders, if the students with whom they do not get along well are in the same group, if there are students who are reluctant to be a leader, and if there are naughty or distracted unsuccessful students". To illustrate, IUGS1 stated the positive effect as "students' motivation increases" and evaluated the model in terms of attracting students' attention: "*It is a model that includes activities attracting the students' attention and that motivates students or offers them an opportunity to express their own knowledge. Therefore, it will attract the students' attention more, and they will get more motivated".* The same participant evaluated the model in terms of achievement level and said, *"Students with a low level of achievement may disrupt the motivation of the group. Alternatively, it may prevent them from thinking in the moment. If s/he is a naughty student, if s/he is distracted, such things may occur".* This paved the way for the result that if there are low-achieving, naughty, or distracted students in the group, these students may reduce the motivation of other students. Similar conditions were identified for most adverse effects. Some other conditional sentences were determined as "if the student is not selected as a leader at all, if the teacher makes a wrong grouping, if the students do not like to share their ideas, if the teacher acts biased in the selection of the leader, if the teacher acts sexist in the selection of the leader".

With regard to the effects on shy and low-achieving students, negative effects emerged as the opposite of positive effects. The condition "if there are students who want to talk a lot" was determined for only one of these negative effects (dominant students may negatively affect shy students' energy). The following excerpts about shy students can be presented as examples. QGS6, considered the positive effect as "the participation of shy students in the course is positively affected". The same participant responded to the question "What are the advantages of the peer-led team learning model?" as *"Students who are ashamed of their teacher can actively participate in the lesson.".* IUGS1 mentioned the negative effect with such a saying as "the motivation of shy or quiet students may decrease". This participant responded to the question, "So what do you say about the disadvantages of the model?" as *"...those who are silent may not join; their motivation may decrease."*

"Skill" Category

This category encompasses 34 codes, 29 of which were positive and 5 were negative. Most of the codes in this category were related to communication skills, and some were associated with other skills. Figure 3 presents the emerging codes with the highest number of participants and those for the special student group: the frequency of the codes (f) and the number of participants (n). Besides, the details of other skills are provided in Figure 3 since all of the codes that come into prominence are related to communication skills.

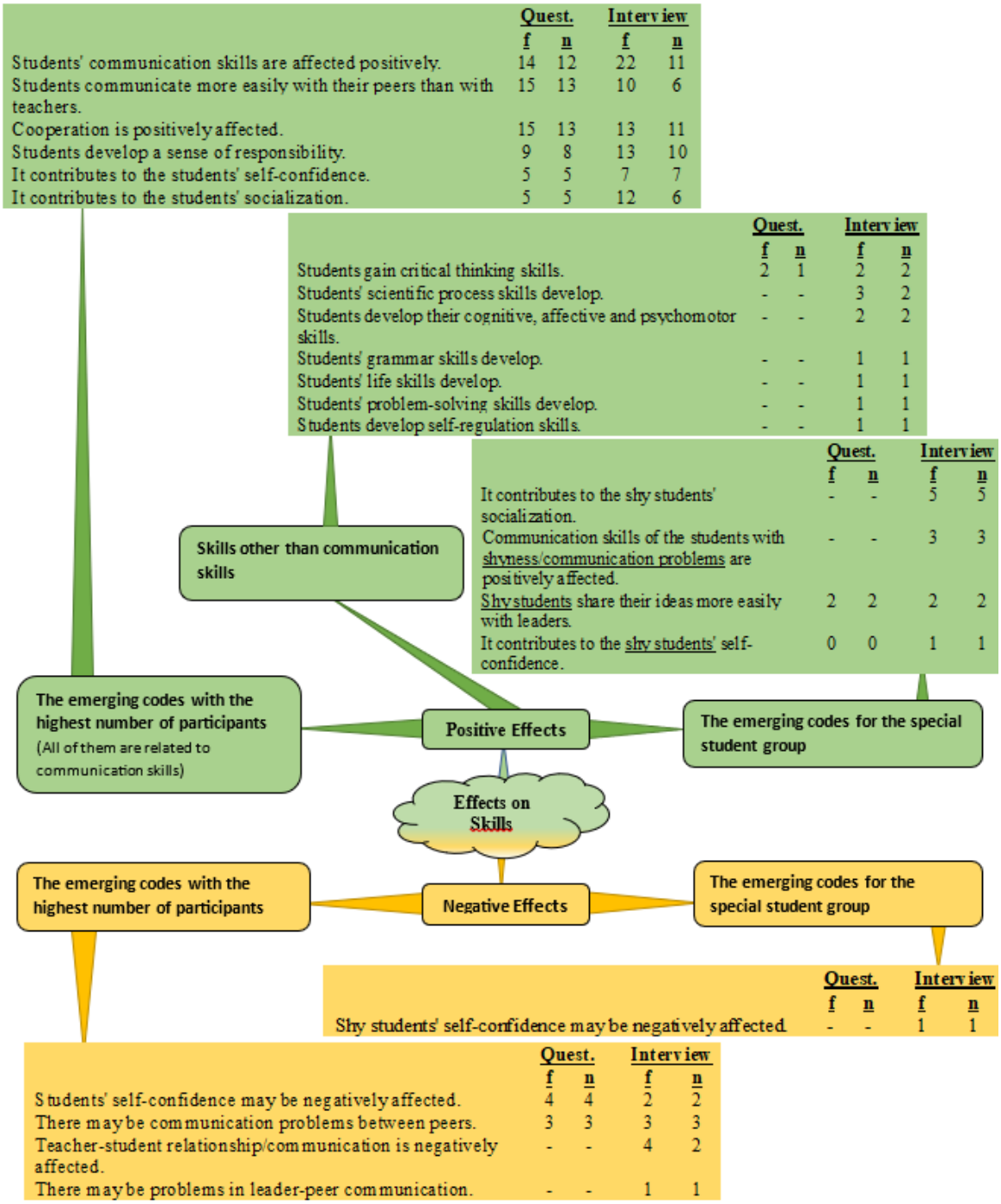

Figure 3. The emerging code samples in the "Skill" category

Figure 3 suggests that the number of participants expressing positive effects in the questionnaire and interview data was higher than that of those with negative views. Hence, more participants agree on the positive effects.

As in Figure 3, all of the prominent positive and negative effects in this category were related to communication skills. The effects on critical thinking, grammar, scientific process, life, problem solving, self-regulation skills, and cognitive, affective, and psychomotor skills were stated by a small number of participants with these names. Other effects that were not included in the figure were noted as positive effects related to communication skills, such as "contributions are provided to students' group consciousness, empathy development is positively affected, and students learn to respect each other".

Most of the participants implied that "the students' communication skills are positively affected". QUGS2 responded to the question, "What are the advantages of the peer-led team learning model?" as *"...other students in the group complement themselves and develop their social communicative skills because they support each other while learning."* Besides, IGS7 replied to the question, "Do the results of the competition affect the students?" with such words as "*I think it has positive effects. They will work harder in order to achieve more in a competitive environment, which means an increase in their academic success and in their communication skills."* The following excerpts were related to another positive effect with the highest number of participants (Students communicate more easily with their peers than their teachers): QGS20 answered the question "What are your suggestions for the use of the peer-led team learning model in lessons?" as *"I think it is significant for students to use it in lessons because they sometimes have difficulty expressing what they think is wrong or incomplete to the teacher, but they express themselves more freely in sharing their knowledge in the same environment with their peers".* IUGS3 underlines that the model facilitates learning with such a statement as *"I think learning gets easier. We learn more easily with friends. When we are confused, we cannot ask the teacher so that the lesson will not be interrupted, or we are ashamed, but we learn more easily with our friends."*

As in other categories, this category also involves negative effects that are the opposite of positive effects. In three of the five negative effects, the participants implied conditions such as "if the leader is a student who is disliked by his peers; if the students behave in a way that offends each other; if there is a cynical attitude in the group". For instance, IGS6 stated that "Contribution is provided to the shy students' self-confidence." The same participant mentioned the effects of the model on the students' self-confidence with the words *"If they are afraid of their teacher or if there are shy students who do not communicate, they can establish better contact with the leaders and improve their self-confidence".* As the opposite of this positive effect, GYLÖ5 announced the negative effect "Shy students' self-confidence may be adversely affected" while talking about the effects of the model on students' self-confidence with such words as *"...but as I said, this may damage students' self-confidence who are reluctant to talk to any passive friends and to share their thoughts with the teacher.".*

Findings on the Second Research Question

The second research question of the study was "What are the views of the fourth-year pre-service science teachers and science education master's program students regarding the effects of the PLTL model on peer leaders?". Findings about peer leaders are summarized in the following sub-headings, with comparisons to those related to peer students.

"Learning" Category

This category held 15 codes, 12 of which were positive and three were negative. Ten of the positive effects were also identified for peer students, and two were determined only for peer leaders. Those that were only related to the peer leaders were the unconditionally mentioned views: "peer leaders' spending more time than other students provides them with the opportunity to learn better" and "peer leaders' thinking activities improve". Most of the positive effects mentioned only for peer students were related to shy, slow learners, or unsuccessful students and had nothing to do with peer leaders. Upon comparing the positive effects on peer students and peer leaders in terms of the number of participants, some effects came into prominence for peer leaders. These are: the model will enable students to reinforce their knowledge, and the course success and knowledge of the students will increase.

All of the negative effects identified for peer leaders in this category were also among those determined for peer students. These negative effects on peer leaders were much less severe than on peer students, and fewer participants shared them. These codes were related to the view that "the students' learning or understanding of the subject becomes difficult, the efficiency of the lesson may decrease, and students may have misconceptions". The conditional sentences for these views were as follows: "If the students are reluctant, if the same model is used all the time, if the leader uses the direct instruction method, if the leaders are chosen incorrectly, if the teacher does not give feedback and corrections, and if the teacher cannot manage the process well".

"Motivation/Attitude" Category

28 codes were identified, 18 of which were positive and 10 were negative. All of the positive effects were those that were also observed in peer students. On the contrary, most of the six positive effects that were not identified for peer leaders but only for peer students were related to shy students.

Five of the 10 negative effects were also found in peer students. Five negative effects identified only in peer leaders were: "Leaders may have difficulty managing their groupmates or learning process; leaders' spending more time than their peers may negatively affect their motivation; it may not attract the attention of every leader; peers' negative behaviors may force leaders; leaders are reluctant to teach". Conditional statements for these negative views were "if they fail, if students cause problems, if there are disagreements between peer students and leaders, if the leader does not have all of the leadership qualities". Unlike the leader students, most of the negative effects found in peer students were related to shy or low-achieving students.

"Skill" Category

This category had 24 codes: 23 positive and one negative. 20 of the positive effects were also identified in peer students. Three positive effects only related to peer leaders were the views that "leaders' friendship develops, it contributes to the increase of leadership characteristics, and it contributes to the development of personal skills". Considering the positive effects that were not found in the peer leaders but only in the peer students, most of these effects were found to be related to shy students. In addition, some positive effects on peer leaders were more prominent than on peer students. These effects were expressed with such views as "students' awareness of taking responsibility develops" and "students' self-confidence improves".

The negative effect was expressed as "the model affects the students' self-confidence negatively", which was also determined for the peer students. Only the condition "if students act in a way that offends each other" was specified in order for this negative effect to emerge.

Result and Discussion

This study aims at exploring the views of the fourth-year pre-service science teachers and science education master's program students at a state university in Turkey regarding the effects of the use of the PLTL model in science courses on peer students and peer leaders. In this regard, the results revealed that the PLTL model could have positive and negative effects on the "learning", "motivations/attitudes" and "skills" of peer and leader students. Since the number of participants with positive effects identified in both questionnaire and interview data was much higher than the number with negative effects, much more participants agreed on positive effects.

When examining views on the positive effects of the PLTL model on students' learning, it becomes clear that participants believe that the implementation of this model will lead to improved learning outcomes. Specifically, they anticipate increased permanence, higher course achievement, greater course efficiency, and an easier understanding of the subject. Various studies were conducted at the university level to investigate the effects of the PLTL model on students' achievement in science subjects. In their study on biology and chemistry, Tenney and Houck (2003) concluded that the PLTL model increased achievement and that the interaction of peer students with leaders and each other helped them understand the subjects. Tien et al. (2002) examined the long-term success of students in an undergraduate organic chemistry course at a university in the United States of America and revealed that the success rate was more positively affected than the students who did traditional recitation. Similar results emerged in the studies conducted by Hockings et al. (2008), Lewis (2011), and Young and Lewis (2022). Eren-Şişman et al. (2018) compared the PLTL model with traditional teaching for general chemistry course achievement at a university in Turkey and found positive results, especially for low and medium-level successful students. In their study on university-level physics, Zorlu and Zorlu (2020) concluded that the students in the experimental group, in which the PLTL model was applied, had a more positive view of "the model encouraging active learning" than the control group. Though the numbers are fewer than at the university level, some studies demonstrated that the model could be implemented at the high school level (Cracolice & Deming, 2012), that it increases achievement in the ninth-grade chemistry subjects (Lamina, 2021), and that it increases achievement and conceptual understanding in the 11th grade biology subjects (Wells, 2012). Only one study has been found on science subjects with third-grade students at the primary school level. This study suggested that the achievement of peer students who witnessed the PLTL model increased significantly compared to the control group (Okeya, 2022). One study has been found to have been carried out on science subjects at the secondary school level. In this study conducted by Ahmed and Haji (2022) on science subjects with seventh-grade students, the PLTL model had no effect on the students' academic achievement. No such study has been published based on the PLTL model at the middle school level in Turkey.

As regards the participants' views regarding the positive effects of the PLTL model on the "motivation/attitudes" of the students, they emphasized particularly that the students' motivation will increase, their participation in the lesson will be positively affected, their attitudes towards the lesson/subject/teacher may

increase, their interest in the lesson will increase, they will be able to compete positively, and the lessons will be more fun. In their study conducted with university students on chemistry, Hockings et al. (2008) determined that the students participating in the PLTL model practices had a positive attitude towards the implementation of the model in the classroom, and they enjoyed sharing their ideas as well as participating in activities that ensured cooperation between them. Likewise, Wells (2012) found that high school students exhibited a positive attitude towards the implementation of the model in biology subjects. Tien et al. (2002) also noted that the model offered positive developments in university students' attitudes towards the course.

With respect to the positive effects of the PLTL model on the students' "skills", the participants indicated that students' skills such as communication, critical thinking, scientific process, psychomotor, and problem-solving skills would be positively affected. Unlike this result, Eren-Şişman (2020) implicated that the PLTL model did not contribute positively to the university students' social anxiety. In the study, it was stated that the students' inability to develop strong social skills may be among the reasons for this result. In addition, the study revealed that a learning environment could be created to improve the peers' social relations and skills with longer-term implementation of the practices and more experienced leaders. Erişmiş (2017) carried out an implementation similar to the PLTL model in the simple electrical circuit unit with the fourth-grade students and concluded that the students stated that the process provided ease of communication. Ahmed and Haji (2022) underlined that PLTL practices had a positive effect on developing students' teamwork skills. In their study on university-level physics, Zorlu and Zorlu (2020) found that the students in the experimental group, where the ALTÖ model was applied, had more positive views on "encouraging student-faculty member communication, encouraging cooperation among students, and respecting different abilities and learning styles" compared to the control group.

The effects mentioned above were generally positive and common to peer and leader students. In addition, various specific positive effects were identified for only peers or only leaders. Among the positive effects determined only for peer students, the ones that stand out mainly were related to shy, slow learners, and unsuccessful students. Examples of these effects are: "The learning speed of slow learners or unsuccessful students may increase; their learning may be easier; a more productive learning environment may be created for shy students; the model will increase the motivation of shy students; their participation in the lesson; their interest and attitudes towards the lesson; and shy students' communication skills will be positively affected; they can share their ideas more easily with the leaders; their shyness will decrease in the process; it will contribute to their socialization; and their self-confidence will develop". These views about shy, slow learners, and unsuccessful students are thought to be significant in the present study. There is a dearth of studies with similar results regarding the PLTL model (Tien et al., 2002; Hockings et al., 2008). In a study conducted in the United States of America related to PLTL practices in biology subjects at the university level, there was a drastic reduction in the failure rate of underrepresented minority students, which further resulted in closing the achievement gap between minority students and other students (Snyder et al., 2016). Similar results with regard to minority students at the university level emerged in various studies (Lewis, 2011; Tien et al., 2002). As for the positive effects identified only for the leader students, the participants affirmed that peer leaders' spending more time than other students provides them with the opportunity to learn better, the model increases the students' leadership characteristics, contributes to the development of their personal skills and self-development, and the leader status at the middle school level will have positive contributions for the leaders. Besides, this study suggested that some positive effects were more prominent in leaders than in their peers. These are: the model will enable students to reinforce their knowledge; students' success in the course or knowledge will increase; students' awareness of taking responsibility will develop; and their self-confidence will improve. These results are consistent with those in the relevant literature. Gafney and Varma-Nelson (2007) published that the PLTL model reinforced the breadth and depth of the leader students' learning, helped them develop personal qualities such as perseverance and confidence, and fostered teamwork and presentation skills. Snyder and Wiles (2015) confirmed that the model improved the critical thinking skills of peer leaders. In another study, the peer leaders reported enhanced problem-solving skills and understanding of basic concepts during the PLTL practices (Tenney & Houck, 2003). Similarly, Dreyfuss et al. (2021) announced that the use of PLTL enables leaders to become better problem solvers, to be more aware of their learning approaches, to develop better study habits, and to have confidence in their own lives. In addition, some studies, including those of peer leaders, found similar findings, although the PLTL model was not employed. Yardım (2009) stated that the most important cognitive effects of the method were that students learned while teaching, their academic success increased, and their problem-solving skills developed. Erişmiş (2017) examined the views of peers in the role of trainers about the process. Accordingly, the peers were determined to express positive views on various aspects such as increasing their self-confidence in the process, contributing to their self-awareness, taking responsibility, empathizing, active participation in the lesson, communication, information transfer, narration skills, and having fun.

Despite the positive effects mentioned above, the model may have negative effects on students in terms of learning, motivation, attitude, and skills. Gafney and Varma-Nelson (2008) stressed that the PLTL model requires a significant amount of student time and energy. In this vein, the participants stated that the leaders spend more time than necessary, which may cause a disadvantage. One of the views mostly expressed by the participants as a negative opinion was that the leaders might transfer false information. If leaders cannot be trained well in peer teaching, negative effects such as misinformation may occur (Karadağ, 2004: 49). As a solution to this situation, Karadağ (2004) advised that peer teaching methods be handled sensitively and well. Another view, which was more common than the others, was that students may have misconceptions. Participants believed that the model may create a misconception if the teacher makes the group arrangement wrong, if the leader is chosen incorrectly, or if the leaders have misconceptions. All of these conditions are actually related to the teacher's ability to manage the process. Therefore, the necessity of effective process management may be a significant suggestion for educators to eliminate this problem. The fact that the participants put forward conditions for many of the negative effects should not be underestimated. Hence, these conditional sentences are expected to shed light on educators.

Upon examining the possible positive and negative effects of the PLTL model, the positive effects were identified as valuable for the education process, and the negative effects may be eliminated or minimized. Various studies revealed the positive effects of the PLTL model on students' learning, motivation, attitudes, and skills, especially at the university and high school levels, which can be considered an indicator of the potential of the possible effects determined for the middle school level to go beyond probability. In this regard, the present results may help educators when they consider using the PLTL model in education and research processes.

Authors Contribution Rate

The authors contributed equally to the paper.

Conflicts of Interest

There is no conflict of interest for individuals or institutions in this research.

Ethical Approval

The Ethics Committee approval (04/12/2020-06/15) was obtained from Çanakkale Onsekiz Mart University for this research.

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