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The Effect of Teacher Evaluation and Self-Evaluation on Pre-service Teachers' Inquiry-Based 5E Lesson Plan Design and Teaching Practice

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Abstract

The purpose of this study is to investigate the effect of teacher evaluation and self-evaluation on the experience of designing and applying lesson plans according to the 5E inquiry model and pre-service teachers views regarding the 5E inquiry lesson planning and teaching practice. It was designed as the embedded mixed method. Total of 60 pre-service science teachers participated in this study. The data collected by the 5E Lesson Plan rubric for inquiry-based teaching which developed by Goldston et al., (2013), self-evaluation form, and interviews. In the analysis of quantitative data, Wilcoxon Signed Ranks test and Spearman's Rank Correlation, which are among the nonparametric tests, were used. Content analysis was performed in the analysis of qualitative data. Results showed that the average score of pre-service teachers' lesson plans is higher in the second plans. It has been determined that self-evaluation contributes to better planning of the process. The pre-service teachers stated that the 5E inquiry model was particularly strong / effective and their lesson plans' phases of explain and explore were weak. In line with the results obtained in the research, suggestions were made to evaluate and develop the lesson planning and teaching practice according to the 5E inquiry model.

Keywords: 5E lesson plan evaluation, 5E inquiry-based lesson plan, inquiry-based lesson plan rubric, self-evaluation, teacher evaluation

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Introduction

Inquiry-based science teaching played a crucial role in two reform documents, (National Research Council [NRC], (1998) and Benchmarks for Scientific Literacy [AAAS], 1993) in the 1990s in line with Project 2061 in America. Based on the reports published by NRC (1998), inquiry-based science teaching was described as (a) raising curiosity and ask questions; (b) proposing preliminary explanations or hypotheses; (c) conducting simple research; (d) collecting data and evidence based on observations; (e) making explanations based on evidence; (f) considering other comments, and (g) sharing explanations. Accordingly, it is aimed that students learn science subjects and grow up as scientifically literate people with their active participation in asking questions, observing, hypothesis, conducting research, creating evidence, interpreting, and sharing results. A course prepared in line with these goals, improves students' research skills, observation, and experimenting skills, and provides experience on issues such as analyzing, explaining, evaluating, presenting, discussing, and peer communication (Guler, & Şahin, 2019).

Although this approach has been introduced as an effective teaching method for a long time, there have been problems in its implementation by teachers (McHenry & Borger, 2013). Researchers determined that manty teachers and pre-service teachers (PSTs) have naïve understandings about inquiry-based teaching (Lakin & Wallace, 2015). There are also some studies argued that PSTs successfully adopt inquiry-based education but are unable to implement it correctly (Capps & Crawford, 2013). For this reason, the studies about how teachers and PSTs plan the inquiry-based teaching and how they actually carry out these plans are still getting interest (Goldston et al., 2013; Lakin, & Wallace, 2015; McHenry, & Borger, 2013; Wang et al., 2020; Wilson et al., 2010).

Inquiry-Based Teaching

Inquiry-based teaching is very important for science teaching (Desouza, 2017) and has two main goals (Wang et al., 2020). The first is to gain a perspective on science. It provides an understanding of nature of science and scientific inquiry (SI) aspects through a series of activities conducted in line with scientific research, such as making observation, doing experiment, data collection, and making inference. The second is that it is an effective teaching method. With this method, it is possible to teach in a student-centered environment where teachers watch and facilitate the learning process of their students. This learning environment designed in four different ways; confirmation, structured inquiry, guided inquiry, and open inquiry (NRC, 2000; Bell et al., 2005).

Regardless of which level of the learning inquiry was designed, the quality of the process lies in the teacher's knowledge and ability to ask question, research, and explain. Goldston et al. (2013) point out that teachers give reasons for not using this approach in their research. According to this, it was showed that teachers often give the reasons like the pressure of managing the inquiry process,

requiring a lot of time, difficulties of attracting more students with advanced learning of the research process, lack of content knowledge, lack of confidence in answering students' questions, and difficulties of completing all other topics on time (Goldston et al., 2013). Other reasons why teachers present these reasons are that they do not have enough knowledge about inquiry-based teaching, or they have no experience or limited experience about this approach (Akben, & Köseoğlu, 2015; Capps, & Crawford, 2013), and the standards and evaluations offered by the curriculum put pressure on the teacher. (Wilson, 2009). These limited experiences present challenges for planning and implementing inquiry-based lessons (Davis, 2003; Namdar, & Kucuk, 2018).

5E Instructional Model

The 5E instructional model is based on a constructivist approach and has a learning process in which learners create new information alongside their current knowledge. Bybee (1997) re-examined, refined, and in parallel, published the 5E instructional model, one of the most effective teaching models in science education (Bybee et al., 2006; McHenry, & Borger, 2013). 5E teaching model is based on Piaget's mental development model (Desouza, 2017), Learning Cycle (3E) model (Atkins, & Karplus, 1962) consist of exploration, explanation, and expansion phases. The 5E instructional model has five phases; engage, explore, explain, elaborate, and evaluate (Bybee et al., 2006). The 5E model is an inquiry model that offers an opportunity for students to draw on their understanding of science concept.

The recent studies have showed that 5E instructional model is effective in terms of understanding the subject, increasing scientific reasoning, and developing a positive attitude towards science (Özsevgeç, 2006), eliminating misconceptions (Devecioğlu Kaymakçı, 2016; Kaynar et al., 2009), providing better understanding of the knowledge that requires interpretation (Cardak et al., 2008). While some researchers have denied the efficacy of the 5E inquiry model, (Klahr & Nigam, 2004; Kirschner et al., 2006; as cite in McHenry & Borger, 2013), more researchers argue this teaching model effective because it supports scientific thinking besides their acquisitions on conceptual learning (Ceylan & Geban, 2009; Kozcu Çakır, & Güven, 2019). Researchers (e.g., Mesci et al., 2020; Goldston et. al., 2013) have reported that 5E instructional model is useful for teaching inquiry for the ability to integrate both material and research methods into a variety of lessons.

In the context of Turkish science education, the 5E instructional model is often preferred and widely used for lesson planning and presentation in teacher training programs (Namdar & Küçük, 2018). Some researchers also focus on PSTs' views of using 5E teaching model (Bozdoğan & Altunçekiç, 2007), the problems they encounter when designing and implementing activities to appropriate model (Metin & Özmen, 2009), the criteria they determined and used in evaluating course materials (Namdar et al., 2017). For example, Metin and Özmen (2009) investigated PSTs' lesson planning and implementation experiences according to 5E instructional model. The results indicated

that PSTs have a limited understanding of (a) finding interesting activities, asking right questions to determine students' prior knowledge, and attracting students' attention to the subject at the engage phase; (b) finding interesting examples and activities that enable students to actively participate to the lesson, obtaining the necessary materials and using them effectively, and ensuring class discipline during the activities at the explore phase; (c) having enough information about the subject, making enough explanations, and knowing exactly what to do at the explain phase; (d) showing relate the subject to everyday life, identifying different problem situations, and knowing exactly what to do at the elaborate phase; and (e) asking effective questions that will cover the entire subject and suitable for the student level, and knowing how to evaluate at the evaluate phase.

The various assessment tools for evaluating the 5E inquiry lesson plan have been designed (Goldston et. al., 2013; Marshall et al., 2009). An analysis of research conducted origin has been observed in Turkey has limited efforts in this regard. For example, it has been determined that there are researchers who focus on the evaluation of lesson plans by developing a rubric for evaluating lesson plans that are not prepared according to 5E teaching model and targeted only on inquiry-based education, and there are also some researchers who focus on the criteria determined by the PSTs by using the 5E model based on inquiry and the criteria they use (Namdar et al., 2017). Saka et al. (2018) have developed a lesson plan rubric and course observation form only for open-ended inquiry. However, there are few studies on the experience of evaluating and implementing inquiry-based 5E lesson plan structures. However, for PSTs to be effective teachers, the need for research on practical knowledge of the 5E inquiry model still remains important.

The Self-Evaluation

The self-evaluation is a measurement and evaluation method that is parallel to constructivist learning theory. The purpose of self-evaluation can be expressed as creating feedback that encourages learning and performance improvements (Andrade, 2019). Besides noticing the students about what he/she can do, it also gives him/her the opportunity to review them (Şahin, & Şahin Kalyon, 2018). Ozoglu et al. (2008) state that self-evaluation allows students to take a more active role in their own learning. Self-evaluation used in the learning environment also had an impact on increasing class attendance (Kumandaş & Kutlu, 2013). When the opinions about its limitations are examined, it is prominent that self-evaluation is "difficult" and includes "subjectivity". Excessive self-evaluation of students' perception of success (Köstereliоğlu & Çelen, 2016), or the fact that successful students tend to see their achievements lower than they are, or those with low success tend to see their achievements larger (Ross, 2006) create suspicion about self-evaluation. Kutlu et al. (2008) suggest using rubrics (graded scoring key), checklist and open-ended questions to overcome these problems. In this study, PSTs were provided with self-evaluation as part of the evaluation process of the lesson plans.

The Significance of the Study

PSTs experience their first practices in the learning environment by preparing a lesson plan. Although the chosen teaching method is an important guide on how to shape the lesson plan, it may not be easy to plan it to reflect all the details of the teaching. Besides the difficulties in creating a lesson plan, it is not easy to evaluate the prepared plans equally by everyone. Evaluating this information and practices brings with it many methodological problems. Because, in a process that is not sufficiently structured, personal comments of observers can greatly change the results. The need for a teacher-friendly structured assessment tool that can concretely guide inquiry-based teaching practices and in terms of its use comes to the fore (Wang et al., 2020). Meeting this need can guide teachers and trainees as they prepare and implement an inquiry-based 5E lesson plan, as well as trainers who train teachers (Marshall et al., 2009) while evaluating the quantity and quality of inquiry-based teaching. In addition, participation of PSTs in the evaluation process helps them to deepen their learning on this subject and make it more meaningful. For this reason, self-evaluation is one of the most common ways of evaluating students during the teaching process (Kumandaş & Kutlu, 2013). In addition to potentially reducing the workload of teachers, student self-evaluation is assumed to have important learning benefits for students (Ozoglu et al., 2008).

In this study, the effectiveness of teacher evaluation and self-evaluation on the experience of designing and applying lesson plans according to the 5E inquiry model and PSTs' views regarding the 5E inquiry lesson planning and implementation process was investigated. Research questions are determined as follows.

1. How are differentiate between first and second lesson plans total scores and the phases of the 5E inquiry model according to the teacher evaluations?

2. Is there any relationship between teacher evaluations and students' self-evaluations?

3. How do PSTs' self-evaluations affect their lesson plans and their teaching practices?

4. What do PSTs think the 5E inquiry lesson planning and teaching practices (strengths and weaknesses of the process)?

Method

The embedded mixed method, which includes both qualitative and quantitative methods, was used in this study. Mixed method refers to the combination of quantitative and qualitative research, and its main priority is providing a better understanding of the research problem by taking advantage of both approaches (Plano Clark et al., 2008). In line with the purpose of the study, this research method was chosen because qualitative data (open-ended questions and interviews included in the self-assessment) are needed to complete the quantitative data obtained through the evaluation rubric.

In the PSTs' planning and implementing 5E inquiry lesson plans process, the impact of teacher evaluation and self-evaluation was conveyed in accordance with the research structure.

Participants

Sixty (14 male; 46 female) pre-service science teachers, who enrolled an undergraduate teacher education program at the two public universities from Turkey, participated in this study. Purposeful sampling method was used in participant selection. In this method, the characteristics that require compliance with the nature of the study are determined and the people who comply with these characteristics are reached (Christensen et al., 2014, p.150). It was observed that the participant group suitable for the research problem had knowledge and experience in creating science teaching, curriculum, and lesson plans. The research was carried out by taking the consent forms of participation of these PSTs voluntarily.

Research Process

The research was carried out within the scope of three courses which were special teaching methods course, laboratory practices in science teaching course that they were four hours a week and teaching practice course that was 2 hours a week, conducted by all the researchers throughout eight weeks. In the first three weeks, reminder information and practices were completed on inquiry-based teaching and the 5E instructional model. By setting an example of a science lesson, the instructors taught how to prepare and teach a science lesson using the 5E instructional model and introduced the 5E Lesson Plan (5E ILPv2) rubric for inquiry-based teaching (Goldston, et. al., 2013) (see Turkish version in Appendix 1), which was used in teacher evaluation and explained how to use it. After this lesson, a discussion was made on what was planned and done at each stage.

In the last five weeks, PSTs formed groups of two or three in a group. Then, PSTs with their partners were asked to prepare two 5E lesson plans. The 5E Lesson Plan Preparation Criteria and 5E Lesson Plan Template (Mesci et al., 2020) arranged according to the teacher evaluation rubric was given to guide the lesson plans to be prepared by the PSTs. They sent their lesson plans to the researchers by e-mail a few days before their teaching practice, and the lesson plans were reviewed by the researchers and feedback was given at least once. Then, PSTs updated their lesson plans according to the feedback, and practiced in the classroom with micro teaching method. The implementation process of each group was evaluated through class discussions. In this way, PSTs received informative feedback again from instructors and their peers. The researchers observed the PSTs' teaching practices and evaluated them with the 5E ILPv2 during the observation. In addition, PSTs filled the self-evaluation form individually after their teaching practices. In addition, semi-structured interviews were made with thirty PSTs at the end of the semester, and their opinions on their experience about the process were obtained.

Data Collection Tools

The 5E Lesson Plan (5E ILPv2) Rubric for Inquiry-Based Teaching (Teacher Evaluation)

This evaluation rubric, developed by Goldston et al. (2013), was first translated to Turkish independently by the researchers after obtaining the necessary permissions for its use. Later, the translations of the researchers were compared, discussed until the statements reached a common opinion for the expressions that differed, and the first translation of the rubric was completed. The translation of the rubric translated into Turkish was checked by a specialist with English language proficiency and it was determined that the translation was appropriate. In addition, it was presented to the opinion of two science education experts and the rubric was revised in the light of the feedback on the statements. A Turkish language expert was consulted to give the final shape of the rubric and the final rubric was created.

The evaluation rubric includes 7 sections, which are the general features of the lesson plan, the phases of the 5E instructional model and additional lesson plan components, and 28 criteria in total. The section containing the phases of 5E model contains 21 criteria. This rubric is Likert-type instrument with a range of 0–4 points per item. The sections in the rubric, the number of criteria and the highest-lowest scores that can be obtained are shown in Table 1.

Table 1. Sections in rubrics, number of criteria, highest and lowest scores

The sections in the rubric	Number of criteria	Highest score	Lowest score
General features of the lesson plan	3	12	0
Engage	4	16	0
Explore	4	16	0
Explain	6	24	0
Elaborate	3	12	0
Evaluate	4	16	0
Additional lesson plan components	4	16	0
Total	**28**	**112**	**0**

Unlike the original of the rubric, a small formal change was made. The free spaces are added to each section so that the person using the rubric can take notes. Thus, the researchers were able to write observation notes for these sections during the implementation of lesson plans. The researchers followed the written lesson plans submitted before the presentation and observed the PSTs, took their notes to the evaluation rubric, and completed the evaluation.

Self -Evaluation Form

Self -Evaluation form was created from open-ended questions (e.g., what are the three strongest and weakest aspects of your lesson plan? What would you change if you were to redo this plan/implementation?) and criteria in the 5E ILPv2. The open-ended questions are added to the end of

criteria in the 5E ILPv2. Thus, an opportunity was provided for PSTs to indicate the situations in which they could not express themselves during the presentations and discussions. Each PST individually evaluated their plans and practices on this form.

The Semi-Structured Interviews

The interviews were conducted with thirty participants at the end of the implementation process. Ten questions were asked about inquiry-based learning, lesson plan preparing, and implementation processes (e.g., strengths and improvements, difficulties faced, self-evaluation). Each interview took about twenty minutes. Interview questions were formed from the literature and the observations made by the researchers during the whole process. The interviews were recorded, and all audio recordings were transcribed for further analysis.

Data Analysis

As a result of normality analysis, it was determined that the data was not normally distributed. Therefore, the Wilcoxon Signed Ranks test and Spearman's Rank Correlation, which are among the nonparametric tests, were used in the rubric analysis used for teacher evaluation and self-evaluation. In addition, graphic representation from descriptive analysis was preferred.

The open-ended questions of self-evaluation and semi-structured interviews were analyzed by using content analysis. Content analysis is a technique that allows researchers to indirectly examine human behavior/thoughts (Fraenkel & Wallen, 2006). In accordance with the problem in the focus of the researcher, categorizing the information in the data source, making classification, reveals more clear results regarding the situation. Thus, the focus of the research becomes more pronounced and it can determine categories, themes, topics. By following this path, the researchers coded open-ended questions of self-evaluation and semi-structured interviews and analyzed by creating categories and themes.

Validity and Reliability

The reliability of the rubric is expressed as the scoring does not change from one rater to another (the interrater consistency) (Kutlu et al., 2009). One way to determine interrater consistency is to use the Cohen's Kappa formula for each subcategory. Cohen's Kappa (κ) may have a value between -1 and +1, and if value of kappa approach to + 1 then this implies that level of agreement between the two raters is high (Kılıç, 2015; Kutlu et al., 2009). κ value is explained as follows: .01 - .20 insignificant agreement; .21 --.40 poor agreement; .41 - .60 moderate agreement; .61 - .80 good agreement; and .81 - 1.00 very good agreement (Landis & Koch, 1977). When each sub-category is analyzed, Cohen's Kappa values are found to be between .42 and .70, that is, moderate and good level of compliance (The general features of the lesson plan [κ=.70, p<.05], engage [κ=.55, p<.05], explore

[κ=.51, p<.05], explain, [κ=.66, p<.05], elaborate [κ=.42, p<.05], evaluate [κ=.54, p<.05], the additional lesson plan components [κ=.40, p<.05].

Consistency among raters can be determined by looking at the level of compliance on the total scores obtained from rubrics (Kutlu, et. al., 2009). In this context, since the data of the total scores obtained because of the evaluation by two researchers with the teacher rubric tool were not normally distributed, the Spearman Brown Rank Differences Correlation coefficient was calculated and it was determined that there was a consistency between the two scores (rs=.993, p<.05). In addition, to increase the reliability of the graded scoring key, it is better to create a grading between 4-7 to better reflect the difference between the students (Kutlu, et. al., 2009). In the evaluation rubric, as in the original, a 4-point grading (0 = not acceptable / unacceptable, 4 = very good) was used.

Expert opinion may be used to provide the validity of the graded scoring key (Kutlu, et. al., 2009). In this context, the opinions of 4 different experts (one English language expert, two science education expert, and one Turkish language expert) were consulted. For the reliability of qualitative data analysis, inter-coder agreement rate was found 90% with Miles and Huberman's (1994) formula "Consensus/ (Consensus + Disagreement) x 100".

Findings

How does the score of the first and second lesson plans prepared by PSTs change according to teacher evaluation?

During the research process, PSTs prepared two lesson plans and implemented each of them. To determine the difference between the teacher evaluations made for the first and second lesson plans, Wilcoxon signed rank test, which is one of the nonparametric tests, was applied and the results are presented in Table 2.

Table 2. Wilcoxon signed rank test results for difference scores between lesson plans

Lesson plan/implementation (1) Lesson plan/implementation (2)	N	Mean Rank	Sum of Ranks	z	p
Negative Ranks	11	17.27	190.00	-5.338	.00
Positive Ranks	49	33.47	164.00		
Ties	0				

When PSTs' lesson plans are compared, a significant difference was found between the second lesson plan total score and the first lesson plan total score (z = -5.338, p <.05). The second lesson plan total score was significantly higher than the first lesson plan total score.

In the lesson plans, *each phase of the 5E teaching model, features of the lesson plan, and additional lesson components* were evaluated separately. It has been determined that the average score for engage, explore, explain, elaborate phase of the 5E model in the PSTs' lesson plans were higher in the second plans (Figure 1).

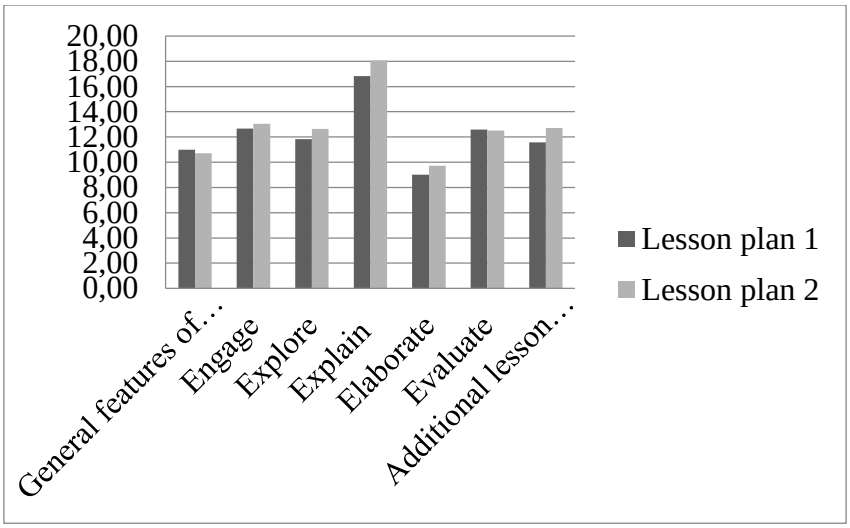

Figure 1. Comparison of the first and second lesson plan points

While the scores obtained from the PSTs' lesson plan features did not change, the scores obtained for the additional lesson plan components prepared for the transition to the next lesson were determined to be higher in the second plan (Figure 1). It was determined that the difference between the second lesson plan and the first lesson plan points was 0.39 points at the engage stage 0.8 points at the explore stage, 1.25 points at the explain stage, 0.72 points at the elaborate stage, 1.15 points at the additional lesson components stage and 13.65 points at the total score (First Lesson Plan $\bar{X}$=85.48, Second Lesson Plan $\bar{X}$= 99.13).

When the PSTs compared their first and second lesson plans/practices, it was determined that they thought their second plans were better. Student quotations on this subject are presented below:

E: Our second plan was better; I believe that we will be better and better with more experience. We learned from our shortcomings. In the second plan, we developed these shortcomings.

S: In the first implementation we were novice. Our second implementation was much better. We prepared the second plan more easily. Because we watched the lesson presentation of our other friends. Our teachers gave them feedback, and this was useful for us. The rubric helped us to prepare the lesson plan.

T: In our second plan, we better reflect the inquiry features. In the second plan, this was easier.

The Relationship Between Teacher Evaluation and Self-Evaluation

It was determined that there was a significant positive (moderate) relationship between the teacher evaluation total score (the average of the two researchers' evaluation) and the PSTs' self-

evaluation total score (rs = .473, p <.05). Detailed information on evaluation scores is presented in Table 3.

Table 3. Teacher evaluation total score and PSTs' self-evaluation total scores

	N	Minimum	Maximum	$\bar{X}$	sd
Self-evaluation	120	71	112	96.05	9.51
Teacher evaluation (average)	120	46	111	87.45	15.76

While the PSTs made self-evaluation, they scored themselves between 71 and 112 points. In contrast, the researchers scored the PSTs between 46 and 111 points. According to this, while the average score of the self-evaluation of the PSTs was 96.05, the average score of the researchers was 87.45 points (see Table 4).

The Impact of Self-Evaluation

In the research, the effect of using the Self-Evaluation Form during the implementation process on PSTs was investigated. The PSTs stated that self-evaluation contributes to their better planning.

S: The evaluation form allowed us to take more planned steps. It showed at what stage, when and how I provided the inquiry.

O: Sometimes, while preparing the lesson plan, we looked at the criteria in it. We prepared the plan by making use of them.

Z: We planned the lesson considering the evaluation criteria. We decided to what was right at what stage by looking at the criteria and we made a better plan

Some PSTs consider self-evaluation as an opportunity to evaluate themselves. At the same time, PSTs stated that self-evaluation is effective in giving them a chance to re-evaluate their experience and to express themselves once again.

F: We wrote what we did on the self-evaluation form. When we wrote there, we thought more about our plan. We have seen our right and wrong. We developed our shortcomings and made our second plan.

H: It was a very necessary implementation. It provided re-think our strengths and weaknesses.

According to the discourses of the PSTs, one of the benefits of self-evaluation is to increase self-confidence.

E: The criteria in self-evaluation helped us about what we should do in our plans and practices. Evaluating myself with the self-evaluation form increased my self-confidence.

M: My self-confidence level has getting high in this process.

A small number of PSTs stated that self-evaluation is not as useful as discussion and feedback. Sample quotations of these PSTs are as follows.

E: Self evaluations were not very effective. The feedback and class discussions were more effective.

G: Self- evaluations have benefited, but not as much as other factors, like rubric.

When was asked to PSTs that what do you think about objectivity of self-evaluation, they stated that they carried out their evaluations in parallel with rubrics (criteria), feedback and classroom discussions.

M: I do not think it is wrong because there are criteria, so we did base on these.

F: I did not have any final grade anxiety. It was already to see what I could and could not do, not for the grade.

Y: You gave us feedback in the classroom and said our shortcomings. I think everyone has filled the self-evaluation forms accordingly.

Views on the Process of Preparing an Inquiry-Based 5E Lesson Plan

When examining the strengths and weaknesses of the PSTs' preparation and implementation of lesson plans, the results are presented in Table 4 about the pre-service science teachers' views of the process of preparing an inquiry-based 5E lesson plan.

Table 4. According to PSTs' strengths and weaknesses of inquiry-based 5E lesson plan preparation and implementations

Theme	Sub-theme	Codes	f(L1*)	f(L2)	Representative Quotes by Pre-service Science Teachers
Strengths of PSTs' preparing and applying of lesson plans	Stages of 5E Model	Engage	13	14	*"The stages of engage and elaborate were really good." "The engage part was effective." "It provided students with interest and motivation."*
		Explore	7	11	*"Activities in Explore part provided students' hands-on and thinking skills."* *"The explore part was completely student-centered. The experiments were suitable for the inquiry process."*
		Explain	3	2	*"I think all the question had been answered and the mistakes had been corrected in this stage."*
		Elaborate	13	18	*"The elaborating stage was very productive." "We created brainstorming by giving examples from daily life in this stage."*
		Evaluate	12	10	*"In the evaluation, the students were very active, and we tested whether they learned or not."* *"The evaluation process was very well understood. The students both had fun and tested what they learned about the subject."*
	Teaching process	Student-centered	10	10	*"Students were active at the engage stage." "The given examples, experiments, questions were in the direction to engage the student."* *"The teacher should always be in a guiding position so as a teacher, we helped students learn and think by doing."*
		Activities	11	15	*"The activities in the engage stage were interesting and aimed at increasing motivation. The demonstration experiment we did in the elaborating stage was good and our evaluation activity was really effective." "The experiments and activities were suitable for the class level."*
		Interest/ curiosity/ attention	7	11	*"The curiosity of the students has been increased at every stage. The students were encouraged to research by asking questions."* *"An engaging, intriguing discussion environment was created."*
Weaknesses of PSTs' preparing and applying of lesson plans	Stages of 5E Model	Engage	13	8	*"We couldn't ask the right questions. Activities for revealing students' prior knowledge were limited."* *"The engage phase was insufficient. We could not make the best atmosphere for the discussion of the students."*
		Explore	14	7	*"Our weakness was that the problems were not understood during the explore stage." "Problems were not clear and understandable"* *"The student should be more active during the discovery phase. We were insufficient in this regard." "We fell into misconceptions."*
		Explain	16	16	*"The students could have been more active in the explain stage." "We could have given the students the opportunity to explain the topic." "In the summarizing of the topic, the students would have made the explanation of the concepts; not the teacher."*
		Elaborate	4	2	*"We could discuss students" answers with the whole class, but we could not."* *"We couldn't do an activity that would relate students' knowledge to their daily life."*
		Evaluate	9	7	*"The questions asked in the evaluation were not clear and understandable."* *"One of our weaknesses was that the true and false questions were missing and inverted sentences."*
	Teaching process	Student-centered	17	13	*"The activities were the teacher was centered." "I couldn't keep the student active." "I couldn't make the students activate." "During the activities I felt it would be hard to control class management in crowed class."*
		SI Aspects	5	7	*"We couldn't emphasize the SI aspects." "We did not mention the SI." "In the lesson plan, we could not address the SI aspects at the right place and right time."*
		Asking Question	7	6	*"I couldn't return the questions back to the students. So I couldn't make them to think with questions." "We couldn't ask different and thought-provoking questions." "In the engage stage, our questions did not create a process that prepares students to inquiry" "We couldn't ask questions that would reveal students' prior knowledge. "*
		Special needs	6	5	*"It was hard to prepare activities according to special needs students."*
		Time Management	9	3	*"The recommended time was insufficient." "We have exceeded the time. We couldn't complete on time."*
		Content Knowledge	3	4	*"Questions from students could not be answered clearly." "I had a lack of content knowledge."* *"I had a hard time answering questions. I realized that my content knowledge was lacking."*

*L1: Self-evaluation of the first lesson plan; L2: Self-evaluation of the second lesson plan

Pre-service science teachers stated that they were strong/effective in the engage, elaborate, and evaluate stages of 5E teaching model, but they were weak in the explain and explore stages. In the teaching process, they stated that the activities they planned and implemented were the strengths of their lesson plans, while they stated that they were weak in making students active, time management, special needs, and the self-content knowledge.

Discussion, Conclusion and Recommendations

Teachers perform better as increasing their experience in lesson planning and implementation. However, managing this process with teacher evaluation and self-evaluation creates a strong supervision mechanism. It is important for the educators to evaluate the problematic areas made by the PSTs better and fairly evaluate the 5E lesson plans prepared by them and to provide feedback on these areas. The 5E ILPv2 (Goldston et. al., 2013), which serves this purpose, was adapted to Turkish in the research process, and PSTs' experiences were investigated throughout teacher evaluation and self-evaluation.

According to the teacher evaluations at the end of the implementation process, it was determined that PSTs showed improvement in the preparation and implementation of the 5E lesson plan based on inquiry. When analyzed the lesson plan stages, it was determined that the average score from each section was higher in the second plan except for the lesson plan features section. The average of the preparation part has not changed in both the first and second lesson plans because the PSTs have not finished off this part completely. It was interpreted that PSTs did not have any problem in finding out some standard information such as the subject selected in this section is suitable for the program, writing the acquisitions, and specifying the materials to be used are requested.

It was determined that the PSTs' scores from each stage of the 5E model were higher in the second plan. The engage stage was the section in which the average scores increased the most compared to the other four stages. This stage was followed by the stages of evaluate, explain, elaborate, explore, and additional course components, respectively. Increasing experience of PSTs in preparing and implementing lesson plans has enabled them to perform better on these issues. Interviews with PSTs also supported these results. Researchers such as Özdem-Yılmaz and Cavas (2016), Namdar et al. (2017), Goldston et al. (2013) drew attention to the importance of increasing the experiences. However, it has to be considered that increasing experience is not the only factor in this change because using a rubric both during the preparation and implementation phases, monitoring their friends' practices, giving feedback by the researchers, peer evaluation with in-class discussions, and self-evaluation also affected the whole process. Namdar and Küçük (2018) stated that the discussions made after the activity increased the interrogation tendencies of half of the PSTs in the lesson plan and the other half did not change. Similar results were found in this study.

Marshall et al. (2009) stated that rubrics to be used in evaluating the quantity and quality of inquiry-based teaching will guide educators and researchers who train teachers. However, while making this evaluation, it is very important how objective it is, independent of personal opinions. For this reason, a control mechanism has been established by comparing the researcher/teacher and PST evaluations by making the self-evaluation of the PSTs. When the relationship between PSTs' self-evaluations and researchers' evaluations was examined, it was observed that there was a statistically moderate relationship. In the study of Kumandaş and Kutlu (2013), it was determined that the PSTs gave themselves more points than the researchers. This situation was interpreted according to the criteria in scoring the presentation achievements, that PSTs made a higher evaluation than the researchers' evaluations. In this study, PSTs stated that they made their evaluations in parallel with the class discussions while transferring their experiences on self-evaluation during the semi-structured interviews. However, they stated that filling out self-evaluation gave them an opportunity to better plan their process, to re-evaluate and express themselves, and to increase their self-confidence. Ozogul et al. (2008) also stated that self-evaluation contributes to the development of critical thinking skills, and that PSTs take an active role in their own learning and increase their potential. In their study, they stated that self-evaluation helped PSTs to raise awareness about the evaluation process and scoring criteria and to better understand the teaching content.

The PSTs reflected the comments of peers and researchers after the implementation to their self-evaluations. In the discussions, peer evaluation approach has played an important role in raising PSTs more qualified and developing their competencies related to teaching profession. Some PSTs stated that classroom discussions and feedbacks given during the process were more effective than self-evaluation. Ozogul et al. (2008) reported that both self and peer evaluation helped PSTs better understand the evaluation rubric and eliminate major errors in lesson plans.

When the PSTs' evaluations about the strengths and weaknesses of the 5E lesson plan were examined, it was found that they did not indicate any strength or weakness about the lesson plan features, additional lesson components, and teaching process of the 5E model. It was observed that all the features indicated as weakness were expressed less in the second lesson plan. It can be said that the increase in the total score in the second lesson plans resulted from the completion of these weaknesses. However, it was observed that the explain phase of the 5E model was described as the weakest in both lesson plans. The PSTs who participated in the research of Enugu and Hokayem (2017) also stated that this stage is the most difficult to write and apply. The number of PSTs who described this stage as a strong aspect was the least expressed among all the strong direction qualifications. When the opinions of the PSTs were examined, it was determined that the reason for qualifying this stage as weak was due to the idea that they could not provide the student with a sufficiently active explanation environment. The PSTs' focusing on appropriate scientific explanations and to learn how to make students active in this stage can help eliminate this weakness (Enugu & Hokayem, 2017). In the rubric

evaluation, the explanation stage was also the stage where the most distant from the full score among all stages. Therefore, consistent results were obtained between the evaluation made with rubrics and the strong and weak direction relation directed in the self-evaluation.

The shortcomings specified for the engage stage are in line with the work of Metin and Özmen (2009). It was determined that there were issues such as not being able to ask appropriate questions, not doing enough studies to reveal prior knowledge, not being able to adequately do the discussion environment that leads to the discovery stage. Expressing this stage as a strong area in the lesson plan, PSTs stated that sufficient interest and motivation was effectively provided. The number of PSTs, which stated that their plans were strong in the process of interest/curiosity/attention, increased in the second plan.

The explore stage is the second most distant to the full score after the explain stage. The PSTs experienced misconceptions in the explore stage, with the lack of knowledge of the area they stated in the teaching process category and could not accurately reflect their problem situations. They also stated that they could not keep the student active enough. The number of PSTs who state the student's active status as a strong feature has not changed in either plan. However, while there was no weakness in effectiveness at this stage of the research activities, it was determined that they developed themselves in effectiveness from the first plan to the second plan and they reflected this on self-evaluation as a strength feature. However, Bayram (2015), Meyer et al. (2013), Namdar and Kucuk (2018) stated that PSTs had difficulty in finding interesting activities. Some of the pre-service were expressed hard to prepare activities for special needs students.

The elaborate phase has not been expressed as a weakness by the PSTs in general. They even stated that the most strength feature of the plans are this stage. On the contrary to the literature that not being able to associate the subject with daily life and not knowing exactly what to do at this stage (Metin, & Özmen, 2009), it was found that the activities were successfully designed in which the relationship with daily life was established and implemented appropriately by the PSTs.

In the evaluate stage, there were PSTs who thought that they faced problems such as not being clear and understandable, not being able to configure correctly. Besides that, there are some PSTs who qualified this stage as a stage that makes the student active and evaluated as fun and learned things correctly. In addition, there were some PSTs who stated that the lesson plan did not apply the SI aspects in the teaching process, did not emphasize it or planned it in the wrong place. It is thought that the PSTs' limited experience in inquiry-based teaching is caused by observing the teaching through lecturing and passing their education life without doing enough research (Saka et. al., 2018). The number of PSTs who consider themselves insufficient in time management is very low considering all the participants. However, the PSTs who stated that managing the time effectively was not determined. The subject of managing time was considered as an issue that was ignored by the PSTs.

The 5E teaching model is a suitable model for in-service and PSTs to develop not only inquiry-based teaching but also an understanding of how teaching process should be implemented. Research findings have shown that 5E lesson plan based on inquiry is effective in preparing and applying experience and showed that the self-evaluation after the implementation with the teacher evaluation had positive effects. The evaluation of PSTs' own plans and their peers' plans through rubrics enabled them to perform better (Ozogul et al., 2008). However, it should be remembered that the rubric helps to determine the quality of the different stages of the 5E lesson plan based on the inquiry, but that a single item or section cannot capture the flow, continuity, and the overall integrity of the lesson plan (Goldston, et. al., 2013). While there is no perfect measuring tool, and while all of them are subjective in some way, it should not be forgotten that the key aspects of the inquiry-based 5E model are always reflected by the 5E ILPv2 (Goldston, et. al., 2013). Self-evaluation may have implications such as identifying excessive errors in lesson plans, providing more constructive feedback, and helping avoid excessive positive feedback (Ozogul et al., 2008). Crawford (1999) stated that teachers' beliefs affect their teaching and learning environment designs (Namdar & Kucuk, 2018). For this reason, it is recommended that PSTs' beliefs and practices are taken into consideration, and similar environments that support their development should be prepared and focus on practices where they can demonstrate their performance. Using the 5E ILPv2 (with self-evaluation) and developing 5E lesson plan preparation and implementation processes are recommended for teachers, PSTs, and educators. The findings of this study are limited with the method applied, the scale used and the pre-service science teachers who participated in the study. To increase the generalizability of the results of the study, it is important to apply it in other samples and to discuss the results.

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Appendix **

Appendix 1. Turkish version of 5E Lesson Plan (5E ILPv2) rubric for inquiry-based teaching

Puanlama Kriterleri					
4 Çok iyi					Maddenin tüm unsurları zengin ayrıntılarla birlikte sunulmuş, tam, uygun ve doğrudur. Başka bir öğretmen bu planı değiştirmeden olduğu gibi kullanabilir.
3 İyi					Madde unsurlarının çoğu zengin ayrıntılarla birlikte sunulmuş, tam, uygun ve doğrudur. Diğer öğretmenler küçük değişikliklerle planı (aşamayı) kullanabilir.
2 Orta					Madde unsurlarının yaklaşık yarısı, bazı ayrıntılarla birlikte sunulmuş, eksiksiz, uygun ve doğrudur. Diğer öğretmenler değişiklikler yaparak planı (aşamayı) kullanabilir.
1 Zayıf					Madde unsurlarının çok azı küçük detaylarla birlikte sunulmuş, tam, uygun ve doğrudur. Diğer öğretmenler dersi uygulamak amacıyla yeniden planlamalıdır.
0 Uygun değil / Kabul edilemez					Maddenin temel unsurları mevcut değil. Açıklamalar uygun değil. Planda tutarlılık yok ve yazılı olarak kullanılamaz.
Ders Planının Özellikleri					
0	1	2	3	4	Ders için seçilen kavramlar ve /veya beceriler MEB 2018 Fen Bilimleri Dersi programına uygundur.
0	1	2	3	4	Ders planı açık, uygun, ölçülebilen ve değerlendirilebilen kazanım/lar içerir.
0	1	2	3	4	Ders planında kullanılan araç/gereç/materyal listesi eksiksiz sunulmuştur.
Giriş Aşaması (Engage)					
0	1	2	3	4	Giriş aşaması öğrencilerin kazanıma yönelik önbilgilerini ortaya çıkarır.
0	1	2	3	4	Giriş aşaması öğrencinin öğrenmeye olan ilgi/motivasyonunu artırır.
0	1	2	3	4	Giriş aşaması öğrencilerin tartışmaları ve soru sormaları için fırsat/lar sunar.
0	1	2	3	4	Giriş aşaması öğrencileri keşfetme aşamasına hazırlar.
Keşfetme Aşaması (Explore)					
0	1	2	3	4	Keşfetme aşaması boyunca öğretmen yapılacaklar hakkında bilgi verir.
0	1	2	3	4	Keşfetme aşamasındaki öğrenme etkinlikleri el becerisine/düşünme gücüne dayalı etkinlikleri içerir.
0	1	2	3	4	Keşfetme aşamasında öğrenme etkinlik öğrenci merkezlidir (Mümkün olduğu ölçüde öğretmen soruları öğrencilerin fikirlerini harekete geçirir veya öğrencilerin yeni sorular üretmesini sağlar. Öğrenci araştırma-sorgulama süreci; öğrencilerin sorgulamalarını, nesneleri kullanmalarını (manipüle etmelerini), bilimsel süreç becerilerini (uygun olanları) ve soyut fikirlerini geliştirmeyi içerebilir. *Bazı bilimsel süreç becerilerinin olduğu listeye bakınız.
0	1	2	3	4	Keşfetme aşamasındaki sorgulama etkinlikleri, öğrencinin neler öğrendiği bilgisini sunar (biçimlendirici ve otantik değerlendirme aracığıyla). *Bazı değerlendirme yöntemlerinin olduğu listeye bakınız.
Açıklama Aşaması (Explain)					
0	1	2	3	4	Keşfetme aşamasından açıklama aşamasına mantıklı bir geçiş vardır.
0	1	2	3	4	Açıklama aşaması kavram ve becerilerin geliştirilmesine öncülük yapacak öğretmen sorularını içerir (keşfetme etkinliklerini / veya keşfetme etkinlikleri boyunca toplanan verileri kullanarak).
0	1	2	3	4	Açıklama aşaması, kavram veya becerileri geliştirmek için öğretmen ve/veya öğrenciler tarafından etkileşimli tartışmayı kolaylaştırmak adına ilişki ve farklılığı ortaya çıkaran sorular içerir.
0	1	2	3	4	Açıklama aşaması, öğretilen kavram veya becerinin tam bir açıklamasını içerir.

0	1	2	3	4	Açıklama aşaması, kavram veya beceriyi açıklamak ve örneklendirmek için farklı yaklaşımlar içerir (Örneğin bu yaklaşımlar teknolojinim kullanımı, alan gezisi, gösteriler, işbirlikli grup tartışmaları, panel tartışmaları, davetli konuşmacı röportajı, video/yazılı/ses/bilgisayar programı materyalleri veya öğretmen açıklamalarının kullanımını içerebilir. Fakat bu yaklaşımlarla sınırlı değil).
0	1	2	3	4	Açıklama aşaması boyunca gerçekleştirilen tartışma veya etkinlikler, öğrencilerin kavram veya becerileri anlamasını değerlendirmek için öğretmene fırsat verir.
Derinleştirme Aşaması (Elaborate)					
0	1	2	3	4	Açıklama aşamasından derinleştirme aşamasına mantıklı bir geçiş vardır.
0	1	2	3	4	Derinleştirme etkinlikleri öğrencilere yeni edinilmiş kavram ve becerileri yeni alanlara uygulama fırsatı sağlar.
0	1	2	3	4	Derinleştirme etkinliklerinin öğrencilerin yeni kazandığı kavram veya becerileri ile günlük yaşam arasında bağlantı kurmalarını destekler.
Değerlendirme Aşaması (Evaluation)					
0	1	2	3	4	Ders planı farklı form/yaklaşımları içerebilen ders sonu (düzey belirleyici-değer biçme) değerlendirmeleri içerir. *Bazı değerlendirme yöntemlerinin olduğu listeye bakınız.
0	1	2	3	4	Değerlendirme etkinlikleri kazanımlara uygundur.
0	1	2	3	4	Değerlendirme kriterleri açık, anlaşılır ve uygundur.
0	1	2	3	4	Değerlendirme kriterleri ölçülebilir.
İlave Ders Planı Bileşenleri					
0	1	2	3	4	İlgili güvenlik konuları ele alınmaktadır. Uygun güvenlik ekipmanları tanımlanmıştır. Malzeme seçimi öğrenci seviyesine uygundur.
0	1	2	3	4	Ders planı aşamalarının her biri için belirlenen süre uygundur.
0	1	2	3	4	Özel ihtiyacı olan öğrencilerin durumu göz önünde bulundurulur. Ders boyunca çeşitli bilişsel seviyelere hitap edilir. Ders bütün öğrenciler için uygundur.
0	1	2	3	4	Ders planı bir kaynakça içerir. Alıntı yapılan eserler içerisinde web siteleri, ders kitapları, çocuk edebiyatı ve ilgili makaleler bulunmaktadır. Sadece çocuk edebiyatının kullanılması kabul edilmez. İçeriği doğrulama için birden fazla kaynak kullanılmalıdır.

** <u>Bazı bilimsel süreç becerileri:</u> tahmin etme, hipotez kurma, gözlem yapma, ölçme, deney yapma, verileri kaydetme, grafik çizme, tablolar oluşturma, sonuç çıkarma.*

** <u>Bazı değerlendirme yöntemleri:</u> bilim günlükleri, bilim defterleri, fotoğraf anlatımları, Ne biliyorum? -Ne öğrenmek istiyorum? -Ne öğrendim? çizelgeleri, kavram haritaları, yazı ödevleri, sanat eseri, çizimler / çizelgeler, grafik çizme, kısa sınav, test, PowerPoint sunumu, film yapma, fil izlemem, çizgi filmler. Ders sırasında kullanılan değerlendirmeler biçimlendirici (formative) değerlendirme, eğer ders sonunda not verme amacıyla kullanılıyorsa düzey belirleyici (değer biçme) değerlendirmedir.*

** <u>İçerikte kullanılabilecek örnek uygulamalar:</u> teknoloji kullanımı, internet gezileri, alan gezileri, el becerisine/düşünme gücüne dayalı öğrenme etkinlikleri, işbirlikli grup tartışmaları, panel tartışmaları, konuk konuşmacı mülakatı, video / baskı / ses / bilgisayar programı materyalleri, öğretmen açıklamaları, online testler, film yapma, PowerPoint.*