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ARGUMENTATION SKILLS OF PRE-SERVICE ELEMENTARY TEACHERS (PSTS) ABOUT OPEN-AIR PRESSURE

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Abstract

In this study, the argument levels of pre-service elementary teachers (PSTs) were examined using The Predict-Observe-Explain (POE) experiments in the teaching of open-air pressure. The participants were 22 pre-service elementary teachers studying at a university in eastern Turkey. The study includes both the development of the worksheets and the application of worksheets. The researcher developed three POE worksheets. PSTs performed the experiments on the worksheets in a laboratory environment. The worksheets were analyzed according to the Toulmin argument rubric, which consists of claims, data, justifications, support, and rebuttals. In the study, PSTs initially struggled to make arguments, but as the application progressed, their ability to make arguments improved positively. Besides, PSTs have limited levels of high-level argument making.

Keywords: argumentation, atmospheric pressure, POE (Predict-Observe-Explain), science education, teacher education

INTRODUCTION

Argumentation in science education

Argumentation is an activity or process that people engage in to justify or test the claims they are defending or opposing (Zarefsky, 2018). Arguments can be expressed in the form of texts containing the allegations and the reasons offered to support them. The main goal of this approach is to enable students to take an active role in the teaching process and to construct knowledge individually and socially in this direction. Information is structured when a claim is made and evidence of this claim emerges, new theories are developed, or existing theories change (McNeill, 2010).

Scientific applications such as argumentation not only help young people learn scientific theories and concepts but also have many benefits for science education (Duschl, 2007; Duschl & Osborne, 2002; McNeill et. al, 2016; NRC, 1996). Besides, the benefits of this method include obtaining an idea of scientific applications, understanding complex concepts, persuading others about science-related debates, using sophisticated language structures, and making personal decisions as a result (Cho & Jonassen, 2002; Jiménex-Aleixandre et al., 2000). These skills enable students to think like little scientists and encourage them to become more involved in social issues. In addition, argumentation is a process with an important potential that gives students the chance to deal with the same events from different perspectives and to establish healthy communication with their peers in discussion environments.

Crowell and Kuhn (2012) state that argument is a skill that allows the individual to be involved in social issues, but the number of individuals with this ability is quite low. As stated in previous research when the goals related to science education are achieved, it is likely to be more successful in science education practices (Bricker & Bell, 2008; Duschl & Osborne, 2002;). When PSTs have previous experience with argumentation-oriented science learning, it is expected that they are more likely to incorporate this basic practice into their classroom settings in the future (Zohar, 2008). Therefore, argumentation-oriented pedagogical learning is considered as the scientific subject that should be included in teacher education programs (Cebrián-Robles et al., 2018; Kaya, 2013).

Prediction-observation-explain (POE) method

POE develops students' higher-order thinking and analyzing skills that lead them to research and inquiry. It can be used effectively in the implementation of the argumentation approach in the learning environment and is highly preferred. POE is an effective method in conceptual understanding because it provides students with the opportunity to compare their predictions with their observations and evaluate the appropriateness of their explanations (Kearney et al., 2001; White & Gunstone, 1992). With the need for prediction, the students are trying to evaluate their existing knowledge. In this method, students actively participate in the learning process by examining, questioning, and explaining. In this way, students structure the information in a permanent and meaningful way (Banawi et al., 2019; Chang et al., 2012; White & Gunstone, 1992).

The importance of the research

PSTs have an important position in creating meaningful and lasting knowledge of primary education level students and in learning the abstract science concepts they see at the beginning of the education process. PSTs should be able to answer the questions asked by children, explain scientific facts of their knowledge levels, and use science concepts correctly. If PSTs understand science concepts, they can effectively transfer them to their students in a learning environment (Duschl, 2007). However, when PSTs acquire false learning and cannot scientifically explain the reasons and consequences of events occurring in an activity, it becomes difficult for them to teach science subjects (Potvin et al., 2015).

The current study provides the opportunity to learn by doing in the laboratory, to create more permanent knowledge, to see the deficiencies in concept learning. The science laboratory and argument method, which provides an effective learning environment, will enable PSTs to participate in experiments and become responsible for their learning (Sampson & Gleim, 2009). Thus, experiments should not be given to learners as a cake recipe, and students should be allowed to make judgments on the subject (Hofstein et al., 2008; Hofstein & Lunetta, 2004; Walker et al., 2011).

The aim of the study is to examine the ability of PSTs to make arguments about open-air pressure. In this direction, three POE strategy-based worksheets on open-air pressure were prepared. The prepared worksheets were applied to the PSTs in the science laboratory.

METHOD

The present study was carried out according to the case study, one of the qualitative research methods. A case study is a method in which a single case or event is examined in depth, data is collected systematically and what happens in the real environment (Subası & Okumus, 2017). The pre-service teachers' arguments about open air pressure were examined.

Sample

The sample consists of 22 PSTs who take the Science and Technology Laboratory Applications course in Atatürk University primary school education department. The classroom training undergraduate program consists of eight semesters in Turkey. In eight semesters of education, PSTs take three courses about science "Basic Science in Elementary School" in the second semester, "Science and Technology Laboratory applications" in the third semester, and "science teaching" in the fifth semester.

Development of worksheets:

While developing the worksheets in line with the POE strategy, the books of (Kesmez, 2010; Petrucci et al., 2010) were used. It was first prepared as a draft and then presented to the expert opinion. Experts evaluated

the worksheets in terms of question content. After the expert opinion, the questions guiding the opinions of the Pts were changed. Instead of these questions, attention was paid to writing questions that do not contain clues about the result of the experiment. For example, in worksheet-3, the question "Why does the balloon inflate while the bottle is filled with water?" has been replaced with the question "What do you expect to happen to the balloon while water is filling into the bottle?". In Worksheet-1, the question "How do you explain the water filling of the glass balloon?" has been replaced with the question "How do you explain what you observe when the glass balloon is turned upside down and immersed in a water-filled beaker?". In Worksheet-2, the question "As the flask cooled, did the rubber balloon get smaller and smaller? Why? " has been replaced with the question "How would you explain the change in the rubber balloon when the flask is cooled?". Questions in the worksheets were revised accordingly. POE worksheets are presented in W-1 W-2 and W-3 appendices.
The language of instruction of the sample group studying at Atatürk University is Turkish. For this reason, the researcher wrote the worksheets in English for a better understanding of the study. For this, the worksheets have been translated from Turkish to English by translators. A different translator translated the worksheets from English to Turkish. The first and last states of the worksheets are suitable for Turkish equivalence.

Implementation process

This process consists of two categories as pre-implementation and during implementation. Experiments, objectives and weekly plan are given in Table 1.

Table 1: Experiments, Objectives of Experiments and Weekly Lesson Plan

Implementation	Weeks	Experiments	Purpose
Before the implementation	first week	Explaining the purpose of the research, informing about the experiments to be done, forming groups, determining the seating plan, explaining the teaching of the lesson, informing the PSTs about the materials to be used in the laboratory and their places	
During the implementation	second week	Rubber balloon attached to the flask	Effect of increased and decreased internal pressure on rubber balloon
	third week	What can happen to the egg?	Effect of pressure difference on the egg
	fourth week	Let's fill the bottle with water	Showing increased pressure of press gas

Worksheet 2 (What can happen to the egg?) is given as an example of how the implementation process is carried out (see Figure 1). Besides, how the videos were used in the process is detailed in the findings section.

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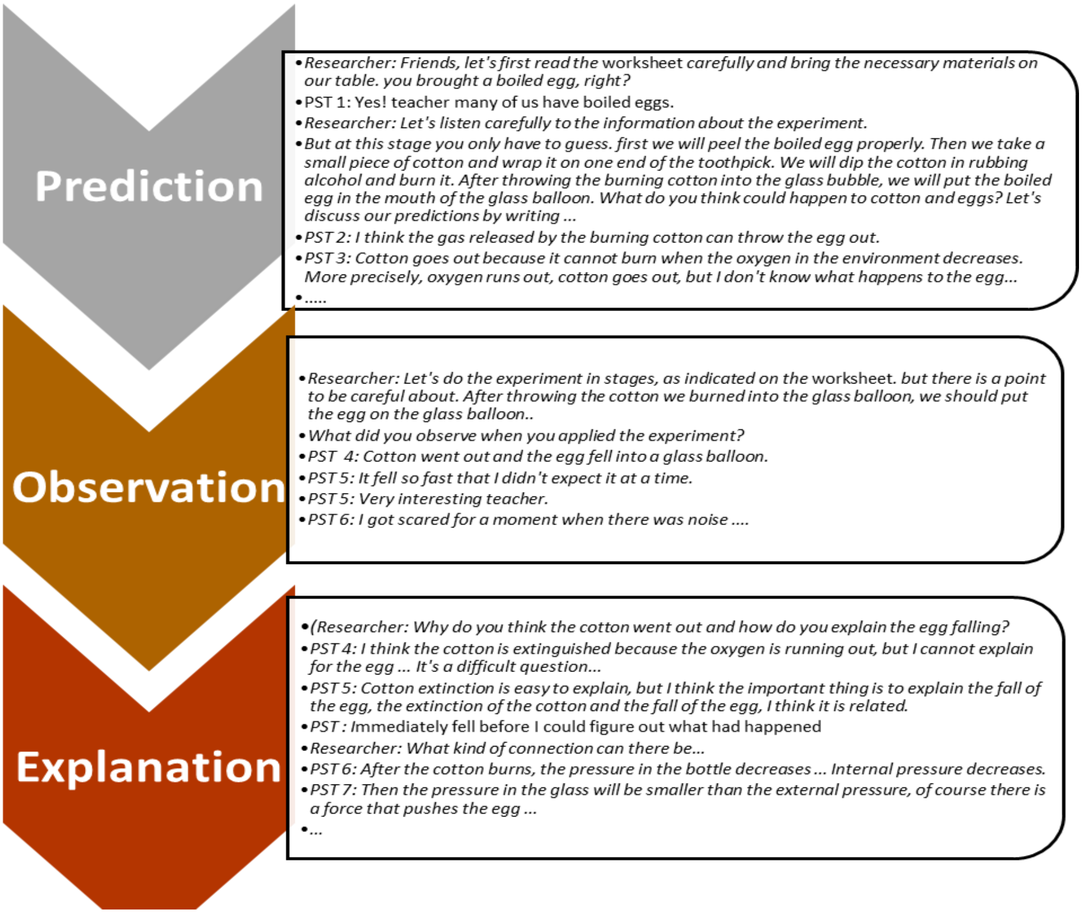

Figure 1: Implementation Process of Worksheet-2

DATA COLLECTION

Data was drawn from the worksheets including the written and verbal answers of the PSTs. It is hard to measure argumentation (Erduran, 2007). However, many models different from the Toulmin model and Toulmin's model were developed to conduct argument analysis in the literature (Chin & Osborne, 2008; Chin & Osborne, 2010; Kelly & Takao, 2002; Kuhn & Reiser, 2004; Lawson, 2003; Sandoval & Millwood, 2005; Zohar & Nemet, 2002). In the current study, data, claim, warrant, backing, and rebuttal elements that constitute the Toulmin argument model were determined as content analysis codes in the evaluation of the data (Simon et al., 2006). The following is a detailed description of the
Toulmin (2003) argument model components used as code in content analysis.

Claim: A thought, result, or explanation put forward as a question or solution to a problem.
Data: Includes facts, cases, or observations used to support the claim. However, different claims can be made with the same data. Therefore, it should be clearly stated why the data used in forming arguments support the claim put forward.
Warrant: Reasons that show how the data support the claim.
Backing: In some cases, case studies or other basic information accepted in the relevant field can be used to increase the acceptability of the justification. This information, which is widely accepted and supports the warrant, is expressed as support in the argument.

Rebuttal: It determines under which conditions the claim will not be true. For a better understanding of these concepts, an example of the implementation of the Toulmin model is given in Figure 2.

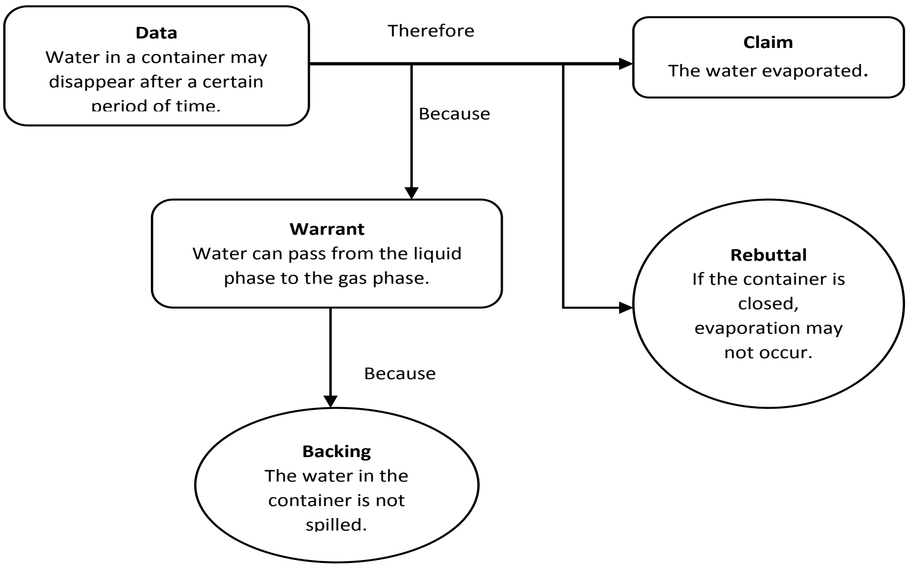

Figure 2: Example for The Implementation of Toulmin's Model (Hofstein et al., 2008)

In the present study, the arguments formed by PSTs were analyzed according to the argumentation assessment rubric developed by Erduran et al., (2004). The rubric developed by considering the argument evaluation criteria in Toulmin's argument model is level 1, level 2, level 3, level 4, and level 5. In the argumentation rubric, arguments that include only claims and use a small number of data, backing, and warrant are weak/poor quality arguments. Arguments that use claims, data, backing, warrant, and one or more rebuttals are strong/quality arguments (Osborne et al., 2004). That is, arguments in Level 1 and Level 2 show weak/poor quality arguments feature, arguments in Level 3, Level 4, and Level 5 show strong/ quality arguments feature (Erduran et al., 2004).

As stated in some studies in the literature, there are some limitations of using Toulmin model (Simon, 2008; McNeill et al.,2006; Jiménez-Aleixandre et al., 2000). Levels 1, 3, 4 and 5 remained the same in the current study. Only the second category is divided into three categories for the correct assessment of the argument development process. These categories are shown in table 2.

Table 2. The Analytical Framework Used for The Third Level

Level 2		
2a	2b	2c
The level of argument supported by false grounds or unscientific data for a claim	The level of argument consisting of a claim and scientific data or partially correct explain	The level of argument consisting of a claim and a scientific data and a warrant, scientifically correct explain

The statements of the pSTs were evaluated according to the argument components (claim, data, warrant, backing, rebuttal). The audio recordings were listened to when the written arguments could not be understood or it was not possible to decide which argument component it was. Secondly, texts containing PSTs statements were given to two experts who had previously studied the argument. Experts were asked to examine student statements and evaluate whether the argument components represented by PSTs statements were appropriate. As a result of the examination, the different parts were discussed and a joint decision was reached. After determining the argument components of the statements of the PSTs, the argument levels were evaluated using the argumentation evaluation rubric (see Table 4). For example, if the PSTs used the claim, data, correct reasons while explaining the situation in the experiment, the argument level was determined as 2c.

In the study, quantitative findings were obtained from qualitative findings for graphical display of data and evaluation of argument levels. To present the data quantitatively, the number of PSTs who responded at each level of argument was evaluated. For example, the total number of PSTs who responded appropriately to the level 1 category in the rising water experiment was written to this level.

FINDINGS/RESULTS

The data obtained from the worksheets were analyzed and presented according to the Toulmin argumentation rubric.

Worksheet-1. Rubber balloon attached to the flask

Table 3: Sample Statements of PSTs According to The argument Components in Worksheet-1

Argument components	Example expressions
data	*Pressure increases as the temperature increases.* *When the* flask *is heated, kinetic energy increases.* *The effect of open-air pressure can explain this situation.*
claim	*When heated, the balloon inflates.* *Balloon contracts when cooled.* *I think the glass could explode.* *When the* flask *is cooled, the balloon can inflate.*
False warrant	*When the balloon is heated, the external pressure increases.* *When heated, the balloon inflates more as the pressure decreases* *Temperature and pressure are inversely proportional. As the pressure decreased, the balloon inflated.* *Internal pressure reacts with external pressure.* *In the second case, air was formed in the* flask *with the effect of ice and it inflated the balloon.*
Warrant	*When the glass balloon is heated, the heated air expands, the expanding air balloon inflates.* *Since the mouth of the glass bubble is closed, the balloon inflates.* *As the temperature is reduced, the balloon shrinks.* *Since the air in the glass balloon is compressed during the cooling process, the internal pressure is smaller than the external pressure. The balloon volume has shrunk.* *When it cooled, the energy was cut because the heat was cut. Because of this, the balloon volume has shrunk.* *When the* flask *is heated, the gas particles in it vibrate and shift.*

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backing	*When the air in the flask is heated, expansion occurs and the gas molecules move away from each other. As the internal pressure decreases when cooled, the balloon contracts.* *When the temperature increases, the pressure increase is expected and the air balloon in the glass inflates. When the air in the glass bubble cools, its pressure will decrease and it will prevent the balloon from inflating.* *When the heated glass balloon is placed in the container full of ice pieces, the balloon returns to its original state as the expanded air in the balloon cools down. As the internal pressure falls with the flesh of ice, the balloon inflates towards the glass.* *In addition to my friends who explained the first and the second situation, the balloon inflates into the* flask*, since internal pressure and external pressure balance must be established in the last case.* *As the internal pressure continues to decrease, the outer pressure balloon inflates inward. We can say that external pressure is greater than internal pressure.*
Rebuttal	*But I think if we did not apply heating or cooling to the glass balloon after the first case, the balloon would just shrink. Because the ice reduces the pressure in the flask.*

Examples of argument levels for worksheet-2 are presented below.

*As we increase the internal pressure when we heat it, the balloon inflates (*warrant*). When it is cooled, we reduce the internal pressure of the balloon (*data*). That's why the balloon slowly deflates (*claim*). Since cooling means reducing the pressure, the balloon has inflated into the glass balloon (*backing*). But I think if we left the flask alone after the initial situation, the balloon would just shrink. If we did not use ice, the balloon would not inflate* (rebuttal) *towards the glass balloon. Because ice lowers the pressure.*

Data+ claim+ warrant+ scientifically correct explain + weak rebuttal The level of argument is 3

*When the glass balloon is heated, the kinetic energy of the air molecules in it increases (*data*) and the balloon swells (*claim*). When the glass balloon is heated, the kinetic energy of the air molecules increases (*data*) and the balloon inflates (*claim*). When the heating process finishes, the pressure in the glass bubble decreases and this situation shrinks (*backing*). As it continues to cool, the balloon inflates into the glass for internal pressure and external pressure balance (*warrant*) and stops when the pressure is equalized (*claim*).*

Data+ claim+ warrant+ scientifically correct explain The level of argument is 2c

Below is an example of the interviews after the experiment is over.
Researcher: Yes, shall we talk about issues that we do not understand or interpret?
…
PST 7: I predicted that the rubber balloon would swell in the heating process, shrink in the cooling process, but its movement into the flask was enormous and unpredictable.
PST 5: I thought the flask would burst in the cooling process.
PST 8: As in the other experiment we observed, this experiment was caused by open-air pressure.
PST 3: In fact, the whole point, as I understand it, was the balancing of internal pressure and external pressure.
PST 1: That's right, but the important thing is to interpret it correctly, balance and imbalance...
…
PST 2: In heating, the air expands, the balloon swells. the pressure decreases in cooling, the balloon shrinks.
PST 4: What about later? That's why I can't create a rebuttal.

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..

Researcher: So, shall we explain it in order? As the flask warms up, the air inside expands, the internal pressure increases and the balloon inflates. When the flask is cooled, the air molecules in it approach each other, the pressure decreases and the balloon becomes smaller and smaller. Until the internal and external pressures are equalized, the external pressure pushes the balloon inward. The rubber balloon swells into the flask.

Worksheet-2. What can happen to the egg?

Table 4: Sample Statements of PSTs According to The Argument Components in Worksheet-2

Argument components	Example expressions
Data	*When the egg is placed on the glass bubble, we prevent oxygen intake.* *Oxygen is required for burning to occur.* *The fall of the egg can be explained by pressure.* *The explanation for the event here can be made by open air pressure.*
Claim	*After putting the egg, the cotton continues to burn for a while.* *Cotton burns until an egg is placed on the bottle.* *The egg continues to stay on the glass bubble.* *The color and shape of the egg can vary.* *The egg may shrink and fall into the glass balloon.*
False warrant	*The egg falls into the* flask *due to the air that occurs when the cotton is burned.* *The egg fell because there was an oxygen output.*
Warrant	*The reason for the egg to fall is that the cotton collapses in an oxygen-free environment.* *The egg fell because of the pressure difference.*
backing	*When the cotton is deflated, the internal pressure must have decreased so that the external pressure is greater than the internal pressure and the egg can enter the bottle.* *Internal pressure is the pressure of the glass bubble, because the external pressure, that is the open-air pressure, the egg quickly fell into the* flask.
Rebuttal	*If we do not place the egg in such a way that it completely covers the glass balloon, we cannot create a pressure difference and the egg will not fall into the glass balloon.* *If we cannot create the pressure difference carefully, the egg will not fall into the glass balloon.*

Examples of argument levels for worksheet-2 are presented below.

The egg could fall into the glass flask (claim*). It's like I saw it somewhere on the internet while researching another assignment, the open-air pressure* (data*). Cotton was burned first and the internal pressure was lowered. As the external pressure was great, the egg fell into the glass balloon (*backing). *If we cannot create the pressure difference carefully, the egg will not fall into the glass balloon, because our egg did not fall on the first try* (rebuttal).

Data+ claim+ scientifically correct explain + weak rebuttal
The level of argument is 3

*Now I feel like the open-air pressure is causing this (*data). *Because when we were in high school, our teacher told something like this. I'm trying to remember to be able to interpret what happened in this activity. Without oxygen, no burning (*data) *and cotton goes out (*claim). *When the cotton stops burning, the pressure in the glass bubble should decrease so that the egg falls (*backing*) with the pressure difference. But one thing should be paid* *attention to, in the first one, the egg did not fall into the glass balloon, which means that if we cannot fully close the egg on the glass flask (*rebuttal 1), *if we cannot create the pressure difference carefully, the egg will not fall into the glass flask (*rebuttal 2).

Data+ claim+ scientifically correct explain + clear rebuttal The level of argument is 4

Below is an example of the interviews after the experiment is over.
Researcher: Yes, I guess it is helpful to explain.
PST 2: Teacher, we fell the egg into a flask on the third attempt.
…
PST 3: Why was not it the first attempt?
PST 4: I do not know. I guess we did not make it.
PST 1: No, you could not make a pressure difference.
PST 8: When the cotton burns, the pressure in the bottle decreases, it is necessary to put the egg on the bottle immediately.
…

PST 7: Because at this point, there is a pressure difference.
PST 9: Then, we'll explain the effect of open-air pressure.
Researcher: Yes, how do we explain it?
PST 6: In fact, open-air pressure does not change. Pressure difference occurs on the egg. When we burn the cotton, we should immediately put the egg into the mouth of the bottle.

…

Researcher: Let's summarize as follows: Initially, the pressure inside the bottle is equal to the external pressure (open-air pressure). The egg sits in the mouth of the bottle. After the cotton burns, the pressure inside the bottle gradually decreases. While the pressure affecting the egg from below decreases, the pressure acting from the top remains constant. Due to the pressure difference, the egg falls into the bottle.

Worksheet- 3. Let's fill the bottle with water

Table 5. Sample Statements of PSTs According to The Argument Components in Worksheet-3

Argument components	Example expressions
Data	*It can be explained by the open-air pressure.*
claim	*The balloon inflates as water flows into the Erlene.* *I thought that all of the water in the funnel would flow into the glass bubble.* *Water fills the balloon.* *I thought all the water in the funnel would fill in the Erlene*
False warrant	*The amount of water flowing into the glass bottle is the volume of the bottle.* *I couldn't explain it because there was no substance in the glass bottle.*
Warrant	*Internal pressure and external pressure balance must be established.* *Air in glass bottle is replaced by water* *When the water flows, the water changes with the air and the balloon swells.* *In the beginning, there's air in the balloon.*
Backing	*There is air in the glass bottle, as the water is filled, the air goes up and inflates the balloon.* *Since the last pressures are equalized, water does not flow, that is, water fills the glass balloon*

	until it is equalized with air pressure. *Water flows into the glass bottle until the internal and external pressure is equalized. Water does not flow as much as the volume of the bottle. Because the rubber balloon prevents the exchange of air and water. In other words, if the balloon was not attached to the bottle, it would take water as much as its volume.*
Rebuttal	*The reason why water did not flow after some water flowed into the flask may be due to the balloon connection to the L pipe. Air and water would continue to shift if we hadn't fastened balloons. it would take in water as much as the volume of a glass bottle.* *If the rubber bubble did not prevent the water in the funnel from flowing, the water will flow the bottle.*

Examples of argument levels for worksheet-3 are presented below.

*I can explain this situation with the concept of open-air pressure (*data*). As water flows into the glass bottle, the balloon inflates (*claim*) until the internal and external pressure equalizes (warrant). As water flows into the bottle, the balloon inflates (*backing*) as the air is replaced by water.*

Data+ claim+ warrant+ scientifically correct explain
The level of argument is 2c

*There is air in the bottle. As the water in the funnel fills the bottle, the air goes up (*backing*) and inflates the balloon (*Claim*). Since we do not change the open-air pressure (*data*) the internal pressure in the bottle is variable (*backing*). When the internal pressure equals the open-air pressure, the water does not flow (*warrant*). In other words, the water fills up until the pressure in the bottle and the open-air pressure equalize. The reason why the water does not flow after some water flows into the bottle is due to the balloon connection to the L pipe (*rebuttal *1). If we did not connect the balloon, the air and water would continue to change places, the glass would take in the volume of the bottle. (*Rebuttal 2).

Data+ claim+ warrant+ partially correct explain+ clear rebuttal
The level of argument is 4

Below is an example of the interviews after the experiment is over.
Researcher: Yes, I think it is better understood when we explain. What did we observe? What happened?
…
PST 2: Teacher, when water flows into the glass balloon, the balloon swells. There is some water left in the funnel.
PST 9: Why do you think there is water left in the funnel?
PST 7: Because the pressure balance is established in the bottle.
Researcher: What do you mean?
PST 3: The air in the bottle inflates the balloon. When the pressure affecting the funnel is equalized with the pressure in the bottle, the water no longer flows.
PST 1: The effect of open-air pressure on the water in the funnel?
PST 4: In fact, the desire to balance pressure
…

Researcher: Let's explain in order: Initially, the inside of the bottle is filled with air. When water flows into the bottle, the air in it is compressed. The balloon, which is in contact with air, begins to inflate with the increase of pressure. Water flows into the bottle. The balloon inflates until the pressure of the air inside is equalized with the pressure acting from the funnel.

DISCUSSION, CONCLUSION AND IMPLICATIONS

Table 14. Change in PSTs Numbers Based on Argument Levels at Experiments

		Level 1	Level 2a	Level 2b	Level 2c	Level 3	Level 4	Level 5
W-1	F	13	3	3	6	1	0	0
	P	60	13	13	27	5	0	0
W-2	F	14	3	4	5	1	1	0
	P	63	13	18	23	5	5	0
W-3	F	12	6	2	4	1	1	0
	P	54	27	9	18	5	5	0

W: Worksheet F:Frequency P: Percent

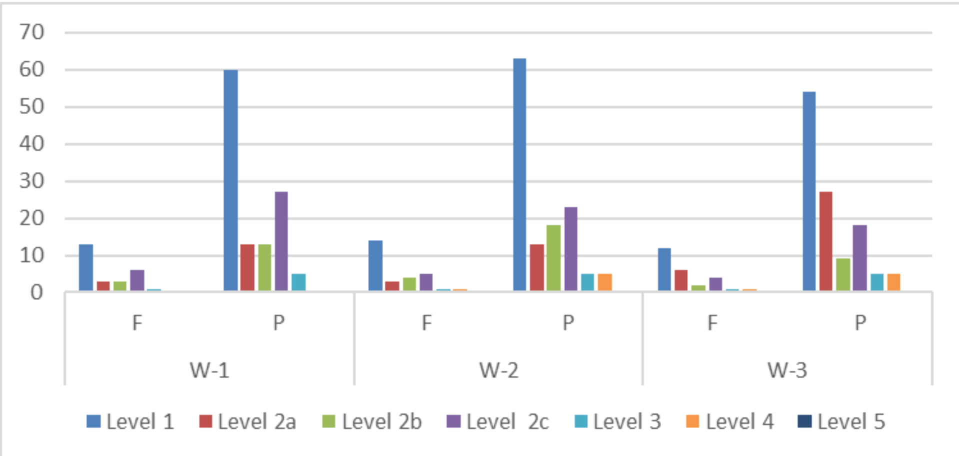

Figure 3: Change in PST Numbers According to Argument Levels

When the application was evaluated in terms of the four weeks, it can be said that the PSTs first struggled in forming arguments and making explanations, and then they adapted to the situation. Besides, after each experiment, the researcher's interviews with PSTs revealed situations that they had difficulty understanding conceptually. At this point, the researcher gave feedback on the experiments thus PSTs could provide a better conceptual understanding and review what they did not understand. Accordingly, it can be said that the PSTs' argument-forming skills improved, although the time was short. In time-spread studies, argumentation-oriented instruction may be more effective in students' forming scientific knowledge and internalizing learning (Walvoord et al., 2008). Examples include two years of work by Erduran et al., (2004) to improve students' argument skills and increase the use of arguments by teachers. At the end of the two-year process, the researchers found an improvement in the quality of the arguments students made. Previous studies indicated that the development of students 'scientific writing skills was difficult and it should be examined with longer studies (Martín-Gámez & Erduran, 2018).

Since level 2 is evaluated as 2a, 2b, and 2c, it is preferred that the number of the PSTs be higher at the 2c argument level (see figure 3). It can be stated that the number of PSTs making arguments at Level 2c generally increased as the application progressed, except for worksheet-3. It is seen that the number of PSTs at argument level 2a is higher in worksheet-3 than in other experiments. Most candidates have difficulty understanding that the pressure of the air inside will increase as the water fills the bottle in Worksheet-3. This situation is thought to limit the PSTs' ability to form arguments. They also based their arguments on the idea that the water in the funnel could flow completely into the bottle at Worksheet-3. As a result, they created false justification and unscientific statements.

In their study, Namdar and Demir (2016) asked students to create posters containing their arguments about the "Spider or Insect?" activity. In the posters created, it was observed that the students could use data, counter-arguments, and rebuttals by the argument components, but they could not use high-level rebuttal. This result can be considered to be consistent with the present study findings. On the other hand, the argumentation-oriented classroom environment includes differences of opinion in scientific discourse rather than conflicts between individuals and offers the opportunity to examine it from a different point of view (Bathgate, et. al, 2015). Therefore, it is thought that the applications in the current study may give the idea of understanding PSTs by questioning the concepts of science they encounter in future science courses.

Further conceptualization and use of arguments are associated with the daily discussion-based competencies that people bring to the classroom (Bricker and Bell, 2008; Chang et al., 2013). Aufschnaiter et al., (2008) reported that students may not have the ability to make quality arguments without knowledge of subject. As the PSTs pointed out, they are surprised that unexpected events occur during in-class events. This stimulated the PSTs' feelings of curiosity and made them want to question and predict the problem of observation. The PSTs, who were critical of the results they encountered at the end of the experiment, tried to establish a cause-and-effect relationship by obtaining learnings about situations they could not have predicted. As in previous studies (Banawi et al., 2019; Chang et al., 2012), POE experiments in the current study attracted PSTs and increased their interest in the course. Pre and post-implementation interviews were conducted with the students in the study conducted by Yerrick (2000), where students were asked to make arguments and design experiments in science class. As a result of the study, it was seen that the students could not establish a cause-and-effect relationship in the arguments before the implementation and could not form a justification. After the application, they reported that they produced alternative solutions to the problems on the subject and were able to evaluate their thoughts.

The researcher tried to gather the PSTs around scientific knowledge through questioning by the principles of the constructive approach. When Table 14 in the study is evaluated, it can be stated that PSTs increase the making of arguments. They are expected to form limited arguments at the third and fourth levels because these arguments are qualified as advanced argument level (Erduran et al., 2004; Osborne et al., 2004).

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Eğitim ve Öğretim Araştırmaları Dergisi

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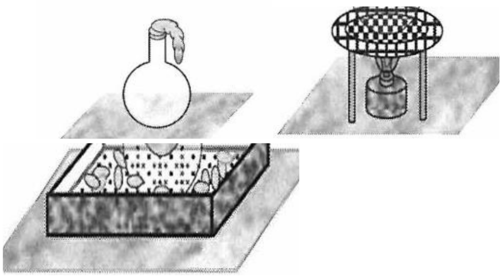

Figure A Figure B

Figure C

Materials used for the experiment:

* flask * tube tongs * ice chips * tub * water * spirit stove * match * wire rack * Rubber balloon, * trivet,

Experiment Procedure:

1.Make it slake by inflating the Rubber balloon for 3-4 times and evacuating the air.
2.Make sure that there is no air in the rubber balloon.
3.Attach the rubber balloon to the mouth of the hollow flask (see Figure-A).
4.Put the trivet on the table and the wire rack on the trivet. Burn the spirit stove and put it under the trivet.
5.Hold the flask with the tube tongs. Heat the flask by moving it in the spirit stove. and follow the rubber balloon (see Figure-B).
6.Observe the changes occurring in the Rubber Balloon.
7.After a few minutes, remove the flask from the spirit stove.
8.Dip the flask into the pre-prepared water-ice mixture. Follow the rubber balloon. (see Figure-C)

Prediction

What can happen to the rubber balloon attached to the mouth of the flask in the heating process? (see Figure B)
What can happen to the rubber balloon attached to the mouth of the flask in the cooling process? (see Figure C)

Observation

What did you observe in the rubber balloon as the flask heated up? Can you write down the observation results?
What did you observe in the rubber balloon as the flask cooled? Can you write down the observation results?

Explanation

Make comparisons between your predictions and your observations. Can you explain the similarities and differences between your observations and predictions?
How would you explain the change in the rubber balloon when the flask is heated?
How would you explain the change in the rubber balloon when the flask is cooled?

What can happen to the egg?
Worksheet 2

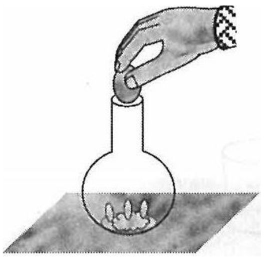

Figure A

Materials used for the experiment:

* flask * boiled egg * cotton * toothpick * rubbing alcohol * match

Experiment Procedure:

Peel the shells of the boiled egg.
Take a small piece of cotton and wrap it around one end of the toothpick.
Dip the cotton in rubbing alcohol and burn.
Throw the burning cotton into the flask.
Put the egg into the flask immediately (see Figure-A). Press the egg lightly to prevent air from escaping the edges. Follow the egg on the flask and the cotton burning in it.

Prediction

What do you expect to happen to the cotton burning in the flask?
What do you expect to happen to the egg on the glass balloon?

Observation

What did you observe in the egg on the glass balloon and the burning cotton in it?

Explanation

Make comparisons between your predictions and your observations. Can you explain the similarities and differences between your observations and predictions?
What did you observe in the burning cotton inside the flask and the egg on it?

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Let's fill the bottle with water

Worksheet 3

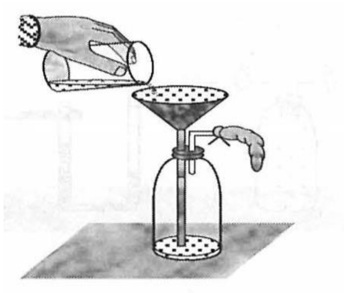

Figure A

Materials used for the experiment:
glass bottle * double hole rubber stopper * L glass pipe *funnel *elastic balloon *thread *water

Experiment Procedure:

- Attach the two-hole rubber stopper to the mouth of the flask
- Firmly insert the funnel in one of the plug holes and the L glass tube in the other.
- Attach it to the mouth of the L glass tube so that there is no air in the rubber balloon and tie it tightly with a rope (see Figure A).
- Fill the funnel with water.

Prediction

Is there any substance inside the flask initially? Can you explain?

What kind of change can occur in the rubber balloon when the water is filled into the funnel?

Observation

How did you observe a change in the rubber balloon and the water filled in the funnel?

Explanation

Can you make comparisons between your predictions and your observations? Can you explain the similarities and differences between your observations and predictions?

How would you explain the change in the rubber balloon?