

A Proposed Program Based on Scientific Causality Approach for Developing Scientific Argumentation Skills among Pre-service Teachers

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Abstract

The study aimed to develop a program based on a scientific causality approach to enhance scientific argumentation skills among Pre-service teachers. The program was applied to an experimental group of 50 participants, using a one-group experimental design. Tests were conducted before and after the program's implementation to assess the participants' scientific argumentation skills. The results showed significant improvements in the participants' scores, with statistically significant differences at the 0.05 level, favoring the post-application results. This indicates the program's effectiveness in enhancing scientific argumentation skills.

Keywords: Scientific Causality, scientific argumentation skills, Pre-service teachers.

Introduction

Causality stands as one of the most fundamental philosophical and scientific principles, playing a pivotal role in the evolution of scientific research and knowledge. Since the dawn of philosophical thought, early philosophers sought to uncover the first causes and reasons for the universe and to delve into the underlying causes behind cosmic phenomena and events. Consequently, causality has provided a comprehensive and overarching view of the universe, affirming that nature is subject to fixed laws and that phenomena are organized according to a specific system. Moreover, the sequence of these phenomena is linked to systems with defined laws and causal relationships (Zorq, 2018, p. 279).

In the case of the universe lacking cause and effect (influence and influenced), events would occur randomly and without regularity, and there would be no such thing as empirical induction. How could scientists generalize the results of their studies of a few cases to all cases within the universe? As an example of the generalization of causal relationships, Newton discovered that the force of gravity is the cause of objects falling towards the Earth. He explained this phenomenon as being caused by a mutual force between the Earth and the object, where this force is directly proportional to the product of the masses of the two attracting bodies and inversely proportional to the square of the distance between them. Newton explained the Moon's orbit around the Earth and the planets' orbits around the Sun as a result of this force, without having any scientific proof of the actual existence of gravity in the Sun or planets (Al-Taie, 2003, p. 87).

As we live in an era demanding critical thinking and evidence-based reasoning, it is imperative to cultivate scientifically literate individuals. This requires nurturing students' ability to think

critically, engage in meaningful dialogue, and master the art of scientific argumentation. Science education should extend beyond mere concept acquisition to foster opportunities for students to participate in scientific discourse and debate. (Al-Khateeb & Al-Ashqar, 2014, p. 73)

To learn science effectively, students must actively engage in scientific argumentation. This involves formulating claims, supporting them with evidence and reasoning, and critically evaluating alternative explanations to arrive at sound conclusions. (Dawson & Venville, 2010, P. 962)

Research Problem

The research problem lies in the "deficiency of scientific argumentation skills among pre-service science teachers, which necessitates the use of modern teaching approaches to enhance these skills. The researcher proposes the use of the scientific causality approach."

To address this issue, the following research questions need to be answered:

1. What is the proposed design of a program based on the scientific causality approach for developing scientific argumentation skills among pre-service science teachers?
2. What is the effectiveness of a program based on the scientific causality approach in developing scientific argumentation skills among pre-service science teachers?
3. To what extent does the proposed program based on scientific causality enhance the scientific argumentation skills of pre-service science teachers?

Research Objectives

The present research aimed to:

1. Identify the appropriate scientific argumentation skills for pre-service teachers.
2. Develop a proposed program based on scientific causality to enhance the scientific argumentation skills of pre-service teachers.
3. Investigate the effectiveness of the proposed program based on scientific causality in developing scientific argumentation skills among pre-service teachers.

Research Significance

The significance of this research stems from the following:

1. **Equipping pre-service teachers with contemporary pedagogical principles in science education** to enhance their ability to achieve curricular goals and develop innovative teaching methods.
2. **Providing a program that helps undergraduate pre-service teachers develop scientific argumentation skills** related to natural phenomena.
3. **Benefiting in-service science teachers and curriculum developers** by introducing a novel approach (scientific causality approach) that can be integrated into science instruction to enhance students' argumentation skills.

4. **Encouraging researchers interested in this field to conduct further studies on the scientific causality approach**, as research is scarce in this area within the science discipline.
5. **Providing curriculum developers with a proposed program based on the scientific causality approach**, including its principles and teaching methods.

Research Limitations

The research was limited to the following:

1. **Subject Matter Limitations:** The research focused on scientific argumentation skills (claiming, justifying, and providing evidence) among pre-service science teachers.
2. **Population Limitations:** The research population consisted of third-year undergraduate students majoring in science education (biology, geology, chemistry, and general science) at the Faculty of Education, University of Arish.
3. **Geographical Limitations:** The research was conducted at the Faculty of Education, University of Arish.
4. **Temporal Limitations:** The research was conducted during the first semester of the academic year 2023-2024.

Research Terms:

Causality

Slibiya (1982, p. 649) defined causality as the relationship between a cause and its effect. The principle of causality is a fundamental principle of reason, often expressed as: "For every phenomenon, there is a cause." Nothing exists without a reason or a cause that explains its existence.

Scientific Causality Approach

The researcher defined it as a teaching approach that encompasses a set of strategies, methods, procedures, and processes employed during the implementation of the proposed program. It aims to help pre-service teachers investigate phenomena and issues, identify underlying causes, and engage in observation, explanation, and prediction. This approach is designed to cultivate their scientific argumentation skills and foster a scientific mindset.

Scientific Argumentation Skills are defined by (Frey et al.,) as "the ability to develop scientific claims by explaining and analyzing the reasons associated with them and then supporting or refuting them with evidence derived from investigations of the natural world."

Scientific Argumentation Skills

The researcher defined it as the ability to engage with claims presented to pre-service teachers about a particular phenomenon or issue. These pre-service teachers then gather data and justifications to either support or refute these claims and subsequently provide evidence to substantiate their stance on the matter, as facilitated by the proposed program.

Part 1: Scientific Causality

The Philosophical Foundation of Causality Theory

Causality is a fundamental philosophical problem that has captivated thinkers since the dawn of human cognition. It holds a central position in modern thought, having been a subject of inquiry for both Eastern and Western philosophers and scientists. The concept of causality has been a particular focus within philosophy in general, and the philosophy of science in particular.

Abdullah (2013, p. 13) defines causality as "the relationship between cause and effect." It is essentially a correlational link between two phenomena, where one is identified as the cause and the other as the effect. This involves uncovering the connections that bind things together.

The Scientific Concept of Causality

The scientific concept of causality posits that the principle of causality has been instrumental in the advancement of science. The scientific understanding of causality suggests that phenomena do not occur randomly but rather follow regular, interconnected, and coherent patterns. The occurrence of one phenomenon causes others to occur. The use of causality in scientific inquiry has significantly contributed to the development of the epistemology of scientific knowledge and the advancement of scientific methods and epistemic approaches. Contemporary scientists have affirmed this, arguing that causality can be expressed as follows: every event in nature must be subject to precise laws, and these laws are governed by specific causal relationships. (Razouk & Hassan, 2018, p. 282).

Phenomenology plays a fundamental role in causality discovery, as it is a theoretical study focused on understanding the relationship between cause and effect in various phenomena and events. This science aims to analyze the factors influencing phenomena and identify the true cause behind their occurrence. Through the study of phenomenology, individuals can also enhance their ability to predict future events and make sound decisions based on available causal evidence. Phenomenology relies on observations, experiments, and scientific data analysis to reach reliable conclusions. Additionally, it serves as a crucial foundation for scientific thinking, innovation, and informed decision-making. (Qutoshi, B. S, 2018)

Nature is an intricate causal network, exhibiting a diverse array of open systems that interact, adapt, and self-organize in response to ever-changing environmental conditions, resulting in a cascade of natural phenomena that are part of an infinite causal chain. (Chatterjee, An 2013).

The Scientific Causality Teaching Approach

Teaching approaches are defined as the foundations, principles, and starting points that underpin a particular teaching method or style. These foundations may be academic, professional, educational, social, or psychological. In other words, a teaching approach represents the general theoretical framework underlying any particular teaching method or style. (Sabry, 2010, p. 21).

The researcher defines it as a pedagogical approach that encompasses a range of strategies, methods, techniques, procedures, and processes employed throughout the proposed program. These components are designed to assist pre-service teachers in investigating phenomena and issues, understanding the underlying causes, and engaging in observation, interpretation, and prediction. This, in turn, is expected to foster their scientific argumentation skills and scientific inquiry processes.

Philosophy of the Scientific Causality Approach

The philosophy of the scientific causality approach is grounded in constructivist theory. It shares several assumptions with constructivism, most notably (Zaytoon, 2007; Al-Kharzi, 2011):

1. Learning is an active, constructive process: Learners engage as scientists, inventors, and discoverers, seeking truth by formulating their own questions, generating hypotheses, and testing them. Learning is not merely the product of development but rather a process of individual knowledge construction and self-regulation.
2. Prior knowledge is a fundamental prerequisite for meaningful learning. The interaction between new and prior knowledge is a crucial component in meaningful learning processes.
3. Learning involves the individual reconstructing their knowledge through social negotiation with others. A learning community is one where individuals negotiate the activities they undertake, as dialogue and discussion within the group stimulate critical scientific thinking. Learners are responsible for defending their ideas and supporting them with evidence gathered through research and inquiry.
4. Learning is most effective when learners encounter real-world problems, situations, or tasks: Constructivists argue that this type of learning helps learners construct meaning from what they learn and fosters their confidence in their ability to solve problems, research, and inquire to reach desired outcomes.

The fundamental principles underpinning the scientific causality approach

The principles of the "teacher as a scientist" approach and the inquiry-based approach can be leveraged to derive the fundamental principles of the scientific causality approach. This can be illustrated as follows:

1. **The principle of science as inquiry:** Science relies on discovery, seeking truth, investigating information, and studying the relationship between causes and effects. This is achieved through processes such as observation, interpretation, hypothesis formulation,

experimentation, analysis, results presentation, evaluation, and other scientific methodologies.

2. **The principle of multiple teacher roles and responsibilities:** A teacher's role extends beyond the traditional delivery of information. Teachers should present content in a manner that encourages students to question causes and effects and to explore the relationships between variables. Therefore, teachers must be truth-seekers, practitioners, and reflective thinkers, capable of posing thought-provoking questions that stimulate inquiry. They must also be leaders. To fulfil these diverse roles, teachers need to possess strong research and inquiry skills, as well as the ability to effectively utilize emerging technologies."
3. **The Logical Connection between Teaching and Understanding Causality:** Teaching for understanding is linked to the pursuit of truth through the lens of scientific causality. This approach deepens learners' knowledge of the subject matter, equipping them with research skills that enable them to identify causes and effects. It also promotes the utilization of prior knowledge, the gathering of information, data, and evidence to reach conclusions, as well as the use of evidence to support arguments and viewpoints. Additionally, it encourages collaborative work and the transfer of these skills to learners.

Learning strategies used in the scientific causality approach

- Scientific inquiry.
- Self-directed learning.
- Cooperative learning.
- Problem-solving approach.
- Discussion and dialogue.

The significance of the scientific causality approach in science

The significance of the scientific causality approach in science education can be summarized as follows:

- Focusing on scientific causality, students can develop a deeper understanding of the subject matter and learn how to apply their knowledge to real-world problems. This approach encourages inquiry-based learning, where students investigate cause-and-effect relationships and connect new information to their prior experiences.
- It enables learners to engage with new content effectively due to their existing knowledge, experience, and skills, which can be applied to both teaching and learning the new material.
- Fosters positive attitudes towards science, scientists, and the teaching profession.
- The approach develops learners' critical thinking, inquiry, and problem-solving skills by requiring them to research, investigate, interpret, analyze, and make connections.

A study that focused on scientific causality was conducted by Ozen (2011). This study investigated the causality between science and physics, concluding that the universe consists of open systems and relationships interconnected by infinite causal relations, governed by certain variables.

Additionally, Weber and Leuridan (2012) explored causality by examining its discussions in conferences and analyzing its interpretations and significance in various sciences such as biology, social sciences, medicine, physics, and mathematics. Also, Maki (2018) found that the proposed program based on the dialectical approach was effective in developing students' understanding of historical causality and some logical thinking skills in the second preparatory grade. The study recommended paying more attention to causality and incorporating it into the curriculum.

Part Two

Argumentation Skills

Argumentation is defined, in simple terms, as the art of dialogue and debate (Hassan Shahata, Zainab Al-Najjar, 2002). Scientific argumentation is defined as a statement that includes one or more issues or opinions that present several propositions about a specific idea, used to persuade the reader or listener through the credibility of the results stemming from this idea. In the case of agreeing with this idea, the argumentation is used to justify the proposed propositions, while in the case of rejection, the argumentation is used to oppose the ideas presented for the idea. (Watton, d, 2009).

Sari and Islami (2020, p. 52) define scientific argumentation as an attempt to substantiate a claim using reasons that appeal to the values of the scientific community. Nuzulah et al. (2023, p. 138) define it as a cognitive activity that refers to the construction of scientific findings and conclusions in light of evidence and support, or the presentation of ideas based on the coordination of claims, data, evidence, and theory.

Scientific argumentation is one of the most common forms of human interaction, being an inherent characteristic of human behavior as we strive to understand the world (Voos & Dykey, 2011; Tippet, 2009). Therefore, scientific argumentation is described as a cognitive and social activity (Sampson & Clark, 2008).

Categorizing Scientific Argumentation Skills

Stephen Toulmin introduced a framework for scientific argumentation in 1985, now known as Toulmin's model of argument. Toulmin's model consists of six elements (Toulmin, S, 2003):

- **Claim:** The controversial proposition that is the subject of the scientific debate.
- **Data:** The evidence that supports the claim.
- **Warrant:** The logical connections that justify the link between the claim and the data.
- **Qualifier:** The conditions under which the claim holds.
- **Rebuttal:** Counterarguments that oppose and potentially invalidate the claim.
- **Backing:** Additional explanations and justifications that support the claim.

Okumus and Unalb (2012) defined a model of scientific argumentation that included five elements that intersect with Toulmin's model of scientific argumentation in terms of claims, warrants, backing, rebuttals, and data from which evidence can be extracted.

McNeill and Krajcik (2011) introduced the CER framework for teaching scientific argumentation, which consists of three components:

- **Claim:** The specific point or position being argued.
- **Evidence:** The data or information that supports the claim.
- **Reasoning:** The logical connection or causal relationship between the claim and the evidence.

The researcher will adopt this model, which is based on a three-step process: presenting the claim or counterclaim, providing evidence, and offering a rationale.

The Importance of Scientific Argumentation in Science Education

From reviewing previous studies, we can conclude the significance of scientific argumentation in science education. Scientific argumentation enables learners to: propose ideas, improve academic performance, deepen their understanding of scientific concepts, enhance their inquiry, investigation, and critical thinking skills, actively engage in core scientific practices, develop a better understanding of the nature of science, and grasp the conceptual understanding of core scientific ideas. Moreover, scientific argumentation supports learners' decision-making skills, increases their ability to deal with socio-scientific issues, and develops their ability to use scientific language and speak fluently about science and scientific thinking like scientists.

Among the studies that have focused on scientific argumentation among science teachers, both pre-service and in-service, is the study by (Essa & Ali, 2014). This study concluded that the integration of the Socratic dialogue and fishbowl strategies in teaching the integrated science course is effective in developing critical thinking skills, readiness for effective communicative performance, and a positive attitude towards learning among pre-service teachers.

Vieira et al. (2015) employed argument-driven inquiry activities for pre-service teachers to enhance their pedagogical content knowledge and argumentation skills in a physics methods course. Grooms, Enderle, and Sampson (2015) aimed to provide a model of argument-driven inquiry for teachers, encouraging students to engage in scientific argumentation by allowing them to design their laboratory activities while emphasizing disciplinary core ideas and crosscutting concepts.

Al-Khatib's study (2016) concluded that the task-based learning strategy is effective in developing achievement, scientific argumentation skills, and positive attitudes toward teaching methods for students with special needs among pre-service female teachers. Cinici's study (2016) aimed to utilize socio-scientific argumentation in pre-service teacher education to construct their knowledge through an argument-based program that provides pre-service teachers with

opportunities to examine, discuss, and construct shared decisions to understand the risks of genetically modified organisms.

Research Hypothesis

There is a statistically significant difference at the 0.05 level between the mean scores of the study group students in the pre-and post-application of the scientific argumentation skills test, in Favor of the post-application.

Research Procedures

- Reviewing previous literature and studies related to causality and scientific argumentation to benefit from them in preparing the theoretical framework of this study.
- Constructing a list to identify the sub-indicators of each of the scientific argumentation skills that are compatible with the scientific causality approach that needs to be included in the proposed program for pre-service teachers, ensuring the validity and reliability of the list, presenting it to the esteemed reviewers, and then finalizing it.
- Preparing the proposed program based on the causality approach by preparing a student's book and a lecturer's guide, presenting them to the esteemed reviewers, and then finalizing them.
- Developing a scientific argumentation skills test: Ensuring the test's validity and reliability, presenting it to a panel of experts, calculating the item difficulty and facility indices, measuring the test's reliability, and finalizing the test.
- Pre-test administration: Administering the test to the sample group before the intervention.
- Implementing the proposed program: Teaching the proposed program to the study group.
- Post-test administration: Administering the test to the sample group after the intervention.
- Data analysis and interpretation: Analyzing the collected data and interpreting the results.
- Recommendations and suggestions: Providing recommendations and suggestions based on the findings.

Research Results

To test the validity of the first hypothesis, which stated: "There is a statistically significant difference at the 0.05 level between the mean scores of the study group students in the scientific argumentation skills test in both the pre-experimental and post-experimental applications in favor of the post-experimental application", at the level of sub-skills and the total score of the scientific argumentation skills test. The paired samples t-test was used to determine the significance of the differences between the mean scores of the study group students before and after the scientific argumentation skills test, and the effect size was calculated to determine the variation in the scores of the dependent variable that is attributed to the independent variable, as shown in the following table:

Table (11): Significance of the differences between the average scores of the study group students in the pre and post-application of the scientific argumentation skills test.

Effect size (d)	Significance level: 0.05	Calculated t-value	Standard deviation (SD)	Mean	Sample size (n)	Group	Maximum score	Skill
8,286	Function	58,592	1,331	13.94	50	Pre-test	30	Overall test
			1,293	26.96		Post-test		

Results at degrees of freedom (df) = 49.

The results indicate that there are statistically significant differences at the 0.05 level between the mean scores of the study group students in the heart and dimensional applications regarding the subscales and the total score of the scientific argumentation skills test, in favor of the dimensional application. Therefore, the first hypothesis is accepted.

As indicated by the effect size (d) value, which ranged from 5,008 to 8,286, there is a large effect size of the proposed program based on the scientific causality approach on scientific argumentation skills, both at the sub-skills level and the total test score. This indicates the effectiveness of the program.

Below is an explanation of each skill separately:

First: The skill of making claims

The researcher defines it operationally as: presenting a statement about the external natural world based on scientific observation, and its purpose is to present the issue or phenomenon through a scientific causality input to students and teachers. The claim is often a scientific fact or phenomenon, and it can describe a relationship between two or more variables.

Table 11-1: Significance of the differences between the mean scores of the study group students in the pre- and post-application of the scientific argumentation skills test, and the effect size, for the skill of claim making.

Effect size (d)	Significance level	“t” test value	Standard deviation (SD)	Mean	Sample size (n)	Group	Maximum score	Skill
6,074	Significant	42,949	0,664	4,74	50	Pre-test	10	Claims
			0,669	9,20		Post-test		

The table above (13-1) reveals that there are statistically significant differences at the 0.05 level between the mean scores of students in the study group in the pre-test and post-test, in favor of the post-test, regarding the skill of making claims.

Furthermore, Cohen's d effect size, which equals 0.6074, indicates a large positive effect of using the scientific causality approach in developing the skill of making claims among pre-service teachers (science departments: biology, chemistry, elementary science education) as its value exceeds Cohen's recommended threshold of 0.14.

Second: Providing Justifications Skill

Providing justifications Skill is operationally defined by the researcher as the presentation of data and information in the form of statements offered by proponents of a claim to support it, or by opponents to refute it, through the scientific causality approach for pre-service teachers. It serves as a link between claims and the provision of evidence.

Table (11-2) shows the significance of differences between the mean scores of the study group students in the pre- post-application of the scientific argumentation skills test, and the effect size, for the skill of providing justifications.

Effect size (d)	Significance level	“t” test value	Standard deviation (SD)	Mean	Sample size (n)	Group	Maximum score	Skill
5,274	Significant	37,291	0,631	4,56	50	Pre-test	10	Providing justifications
			0,824	8,88		Post-test		

As shown in Table 13-2, there was a statistically significant difference ($p < 0.05$) between the mean scores of the study group students in the pre-post-applications regarding their ability to provide justifications, favouring the post-application.

As demonstrated by Cohen's d effect size of 5.274, there was a large positive effect of using a scientific causality approach in developing the justification skills of pre-service teachers (in the science disciplines: biology, chemistry, and elementary science education). This value is significantly larger than the threshold of 0.14 proposed by Cohen, indicating a substantial impact.

Third: Evidence Presentation Skill

The researcher operationally defines scientific translation as the provision of data, information, evidence, and proof to either support or refute a claim. This is achieved through the introduction of science.

Table 11-3: Significance of the differences between pre-post-test mean scores of the study group on the scientific argumentation skills test, effect size, for the skill of evidence presentation.

Effect size (d)	Significance level	“t” test value	Standard deviation (SD)	Mean	Sample size (n)	Group	Maximum score	Skill
5,008	Significant	35,414	0,631	4,64	50	Pre-test	10	Presenting evidence
			0,824	8,88		Post-test		

The table above (13-3) indicates a statistically significant difference at the 0.05 level between the mean scores of students in the study group for pre-post-applications, in favor of the post-application group regarding the skill of providing evidence.

As demonstrated by Cohen's *d* effect size of 5.008, there was a highly positive impact of using a scientific causality input on the development of evidence-based reasoning skills among pre-service science teachers (biological sciences, chemistry, elementary science education). This value is significantly higher than Cohen's suggested threshold of 0.14.

Based on the results, the first hypothesis was accepted, indicating a statistically significant difference ($p < 0.05$) between the mean scores of the study group students in both the pre- post-application of the sub-skills and the total score of the scientific argumentation skills test. These findings align with the results of previous research conducted by Al-Khatib (2016), Suwansil and Pruekpramool (2020), Phadungphatthanakoon (2021), and Septyastuti et al. (2021), which demonstrated the possibility of developing scientific argumentation skills among pre-service or in-service science teachers using various teaching and training models, strategies, and programs.

Fourth: Discussion of Results

The results presented in the preceding tables indicated that the proposed program, grounded in a scientific causality approach, was effective in developing scientific argumentation skills and scientific processes among pre-service science teachers. This attainment of results can be attributed to the following reasons:

- The use of a scientific causality approach contributed to creating a stimulating learning environment for developing scientific argumentation skills and scientific processes. In the introductory phase, questions and stories were presented to introduce the phenomenon or issue, and pre-service teachers posed questions and observations, fostering the skill of making claims. The stage of searching for causes involved collecting, and analyzing data and information, which enhanced pre-service teachers' ability to provide evidence and justifications by identifying the relationship between causes and effects. It also allowed pre-service teachers to use and practice scientific processes while actively engaging in knowledge discovery. The stage of searching for causes and collecting data facilitated the practice of scientific processes such as: observing images and videos, predicting the phenomenon or issue under study, interpreting data and the causes that led to it, inferring results related to the causes, attempting to formulate an operational definition of the scientific phenomenon or issue, and formulating hypotheses. The goal was to scientifically establish the relationship between causes and effects and explain it using a scientific approach based on precise inferences.
- Presenting open-ended scientific phenomena and issues related to students' lives and society, sparking debates and discussions among students and teachers. This involves providing evidence to support claims, enabling students to form sound conclusions and opinions based on the presented evidence. Encouraging acceptance of others' viewpoints

when proven correct, and providing diverse sources for research and study, to discover the causes of these phenomena, formulate hypotheses to predict outcomes, and develop operational definitions. This process allows students to practice scientific processes, leading to their experimental development.

Fifth: Recommendations

In light of the findings of the present research, the following recommendations are offered:

- Conducting training courses for science teachers to train them in the use of the scientific causality approach and to benefit from it in teaching some science topics.
- The need to focus on developing the skills of scientific argumentation among science teachers both before and during service.
- The need to focus on developing the processes of science among science teachers both before and during service.
- The need to focus on including the scientific causality approach as one of the teaching approaches in the teaching methods courses in colleges of education.
- Utilizing the proposed program and referring to it in designing and developing training programs for in-service science teachers, as well as for secondary and preparatory stage students.

Sixth: Suggestions

- A proposed biology program based on a scientific causation approach to develop scientific argumentation skills and scientific processes among high school students.
- A proposed science program based on a scientific causation approach to develop scientific argumentation skills and scientific processes among elementary school students.
- A proposed training program based on a scientific causation approach to develop scientific argumentation skills and scientific processes among in-service science teachers.
- Conducting a survey study on the level of scientific argumentation skills among pre-service teachers.
- A proposed science program based on a scientific causation approach to enhance achievement and attitude towards the subject among preparatory-stage students.

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