Exploring Pre- Service Teachers' Alternative Frameworks in Science

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DOI: https://doi.org/10.51584/IJRIAS.2026.11100054

Received: 26 October 2026; Accepted: 31 October 2026; Published: 05 November 2026

ABSTRACT

In this research paper pre-service teachers' alternative frameworks in different concepts of science have been explored. Twenty pre-service teachers were asked to predict the findings of some simple activities given in the form of questionnaire based on the concepts of heat, Archimedes principle, acceleration due to gravity and mass . Besides predicting the findings they had to explain the reason and give correct scientific explanation to support their findings. In this qualitative study, the findings showed that pre service teachers were not able to predict the correct findings of the science activities conducted and the explanations revealed they had substantial alternate frameworks related to the concepts.Their scientific concepts were revisited through conceptual discussions, cognitive conflict, experiments and inquiry based activities. The implications of the findings for teacher education programs have been discussed.

Keywords: Alternative Frameworks, Pre- service teachers, Heat, Archimedes Principle, Acceleration due to gravity, Mass

INTRODUCTION

Children form ideas about many scientific concepts before even coming to school. These ideas are formed as a result of interaction with environment in which they live, use of technology and everyday experiences (R. Driver, 1981). These ideas are considered to be intuitive or 'common sense' understanding of the world and may differ significantly from the accepted scientific theory and are termed 'Alternative Frameworks' (R. Driver, 1985). Traditionally, these ideas were called 'Misconceptions', however,the term misconceptions is being criticised as it fails to recognise that these ideas have been rationally formed by people.

These ideas play an important role in learning and hence taking into account children's prior ideas becomes very important to choose appropriate teaching strategy, examples, activities and illustrations. Children may develop an incorrect understanding of scientific concepts or rely on rote memorisation rather than developing a meaningful understanding of the underlying principles if these alternate frameworks are not addressed adequately.

It is generally assumed that during the years of schooling, these Alternative Frameworks are adequately addressed through the proper choice of teaching learning strategies by science teachers and hence after years of schooling and university education , a student entering a teacher education program is expected to have sound conceptual understanding and possess ideas of science which are in consonance with correct scientific explanation. It is often assumed that their academic qualifications equip them to possess scientifically correct ideas. But is this assumption always correct? Can pre service teachers also hold alternate frameworks about scientific concepts despite their academic qualifications?

The present study seeks to investigate the understanding of scientific concepts among preservice science teachers and the kind of alternative frameworks they have.

REVIEW OF RELATED LITERATURE

S. Gönen (2008) studied pre service teachers misconceptions about inertial mass, gravitational mass, gravity, gravitational force and weight, and its effect on students learning. Findings showed that pre service teachers had serious misconceptions about the above said concepts and it impacted students' learning.

S.Bayraktar (2009). diagnosed the misconceptions of pre-service physics teachers about force and motion. Results showed that pre service physics teachers hold very strong misconceptions about impetus and active force. And the misconceptions decreased through the years of education. Though, they did not disappear completely.

O, Keleş, H. Ertaş Kılıç, N. Uzun & M. Cansız (2010). Studied pre service and elementary teachers' understanding about measurement units and devices and their misconceptions about mass, weight, heat, temperature, energy and specific heat. Data was collected through interviews and data meaning- analysis table. Findings showed that pre service teachers have misconceptions in the above said concepts.

Kartal, N. Öztürk & H.G. Yalvaç (2011). studied misconceptions that the sixty second grade students of faculty of education have about heat and temperature through multiple choice tests and the reasons behind it. Analysis of data reports students misconceptions about heat and temperature.

U.Kanli (2014). studied the misconceptions of in-service and pre-service physics teachers , about the concept of astronomy . The results showed that pre service and in service teachers had extensive misconceptions about the phases of the Moon, the phases of the Moon during the solar eclipse, reason for seasons and the position of the Sun in the sky.

M.Stefanou, G. Stylos, K. Georgopoulos & K. T. Kotsis (2024). investigated Greek preservice primary teachers' misconceptions of thermal concepts. The results revealed that preservice primary teachers showed alternative conceptions of heat-related phenomena and concepts. The analysis raises questions whether the schools meets the needs of modern society in terms of equipping the future citizens of country with scientific literacy skills.

N.Zeybek (2026). Assessed the knowledge and experiences of pre-service middle school mathematics teachers on transforming misconceptions. For the transformation of misconceptions micro-teaching and peer evaluations were used. Results showed that pre service teachers developed positive attitude towards dealing with misconceptions through micro teaching and peer evaluations.

METHODOLOGY

The study used a qualitative research design to investigate alternative frameworks of preservice science teachers. Twenty pre-service female science teachers enrolled in a two year teacher education program were selected for the study. The participants in the age group of twenty to twenty two years had already completed their graduation in discipline of science (with chemistry and biology as their major subject).

In the science pedagogy course, there is a topic of 'Alternative conceptions and frameworks in science in learners', the researcher being the teacher educator also first tried to study the alternative frameworks of pre - service teachers so that the pedagogy can be chosen accordingly and if teachers' alternate frameworks are identified and addressed only then they can deal it with their learners in schools when they become teachers, with this intent the students enrolled in science pedagogy were selected for the study. The scientific concepts chosen for the study were: heat and temperature, Archimedes Principle, acceleration due to gravity, mass and weight. The participants were administered questionaire individually based on the concepts of heat and temperature, acceleration due to gravity , mass and weight and Archimedes Principle. The questions were as follows:

Q. 1. Scales made of different materials, such as wood, iron, plastic, steel, and stone, were kept in a pen holder in a room for long. Which scale would have the highest temperature?

Q.2. If 1 kg of cotton was placed on one pan of a physical balance and 1 kg of iron was placed on the other pan. Which material would weigh more?

Q.3.Consider a situation in which a stone and a sheet of paper were dropped simultaneously from the same height in the absence of air resistance. Which object would reach the ground first?

Q.4. Imagine an experiment in which cubical blocks of equal dimensions made of different materials such as iron, aluminium, copper, wood, plastic, and glass were very gently released in a beaker full of water one by one at a time and completely submerged in it. Each time if volume of water displaced is collected, which block would displace the greatest amount of water?

Each participant was instructed to write the answer individually supported by correct scientific explanation.

The responses obtained from the participants were analysed qualitatively to identify the nature and type of alternative framework they possess related to selected scientific concepts. Particular attention was given to the reasoning used by the preservice teachers and the extent to which their explanations reflected a scientifically accurate understanding of the concepts. The analysis aimed to identify gaps in their conceptual understanding and explore the alternate framework that persisted despite their undergraduate education in science. Their scientific concepts were revisited through conceptual discussions, cognitive conflict, experiments and inquiry based activities.

Findings and analysis

The responses of the preservice teachers to the questionnaire were analysed to identify alternate frameworks in their understanding. The major findings are presented below.

1. For the concept of Heat and Temperature

The majority of the pre service teachers responded that the iron scale would have the highest temperature. This response suggests that they have associated the conduction of heat of metals with a higher temperature. However, the material that feels hotter or colder to the touch does not necessarily have a higher or lower temperature. Therefore, the responses show pre service teachers possess alternative framework with respect to the relationship between the material of an object, conduction and absorption of heat and its temperature. The participants validated the correct scientific explanation by actually conducting the activity .

2. For Archimedes Principle

The majority of the pre service teachers answered that the iron block would displace the greatest amount of water. This response suggests that the pre service teachers have quite stable idea about floating and sinking that things made of heavy material sink and hance will displace more water which they have constructed from their everyday observations. They fail to interpret this idea in terms of Archimedes principle, relation of equal volumes of regular objects with equal quantity of water displaced.

Since all the blocks have equal dimensions, they have equal volumes. If the blocks are completely submerged, each block displaces an amount of water equal to its own volume, irrespective of the material from which it is made.

The participants validated the correct scientific explanation by actually conducting the activity .

3. For the concept of Mass and Weight

The majority of the pre service teachers responded that iron would weigh more than cotton. This response indicates that the pre service teachers associated iron with heaviness and cotton with lightness. Although iron is denser than cotton, both quantities have the same mass of 1 kg. Under the same gravitational conditions, their weights would also be equal. The responses suggest that the preservice teachers may have relied on their everyday experiences and perceptions of materials rather than considering the given masses.

The participants validated the correct scientific explanation by actually conducting the activity .

4. For the concept of Acceleration due to Gravity

The majority of the preservice teachers responded that the stone would hit the ground first. This response suggests that pre service teachers possessed this idea on the basis of their observations in day to day life that

heavier objects fall faster than lighter objects without accounting for the effect of air resistance. In the absence of air resistance, objects released from the same height at the same time fall with the same gravitational acceleration and reach the ground simultaneously, assuming identical initial conditions as acceleration due to gravity does not depend on the mass of the falling object.

The participants validated the correct scientific explanation by observing a video demonstrating the same activity.

DISCUSSION

The findings of the present study suggest that the assumption that preservice science teachers possess sound content knowledge and scientifically accepted explanations of scientific ideas needs to be reconsidered. The responses of the participants reveal that alternate frameworks may persist even after receiving formal education in scientific disciplines and this finding corroborates with the research findings that pre service teachers were found to have misconceptions about inertia, gravity, gravitational acceleration, force, heat ,temperature, energy, mass ,weight .(O. Keles& others, 2010; Gonen 2008; S. Bayraktar,2009; M. Stefanou & others 2024).

The findings raise important questions about the effectiveness of existing school science and university science education programmes in developing a meaningful understanding of scientific concepts. If alternate frameworks remain unaddressed during years of schooling and university education, preservice teachers may carry these alternate conceptions into their future classrooms. Consequently, they may find it difficult to explain scientific phenomena accurately, identify alternate frameworks among their students, or facilitate the development of scientifically appropriate explanations. This may encourage students to rely on rote memorisation rather than developing a deeper understanding of scientific concepts and their underlying principles.

Therefore, teacher education programmes need to give greater attention to identifying and addressing alternate frameworks among preservice science teachers. Along with developing pedagogical knowledge and teaching skills, these programmes should incorporate opportunities for preservice teachers to examine their understanding of science concepts, critically analyse their explanations, and transform misconceptions through micro teaching, peer evaluations, conceptual discussions, experiments, and inquiry-based activities(N. Zeybek, 2026). Particular emphasis should be placed on helping preservice teachers connect everyday observations with scientifically accurate explanations.

CONCLUSION

The present study concludes that preservice science teachers may hold alternate frameworks about scientific concepts. These findings challenge the assumption that formal education in science necessarily ensures a sound conceptual understanding of scientific phenomena.

The study highlights the need to give greater attention to identifying and addressing alternative frameworks among preservice science teachers. Teacher education programmes should focus not only on developing pedagogical skills but also on ensuring that prospective teachers develop a clear and scientifically accurate understanding of the concepts they are expected to teach. Opportunities for revisiting scientific concepts through conceptual discussions, cognitive conflict, experiments, inquiry based activities and critical examination of existing ideas should be incorporated into teacher preparation programmes.

A teacher who does not have a clear understanding of a scientific concept may find it difficult to explain it effectively or address alternate frameworks among students. Therefore, strengthening the conceptual understanding of preservice science teachers is essential for promoting meaningful science learning in schools. By making the identification and correction of alternate frameworks an integral part of teacher education, it may be possible to prepare teachers who can move beyond rote learning and help students develop a deeper and more scientifically accurate understanding of science.

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