Developing an Understanding of Inertia through Hands-On Activities: Emphasizing Meaning over Rote Memorization

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Abstract. This study addresses the impact of hands-on activities on pre-service science teachers identified as low achievers in physics, aiming to not only enhance their understanding of inertia but also to cultivate effective teaching practices that encourage active student participation. Through a case study conducted with 17 pre-service science teachers, various practical exercises were implemented to enhance comprehension of inertia and foster active learning engagement. Findings reveal a varied understanding of inertia among participants, with misconceptions prevalent. While participants demonstrated interest and perceived advancements in their comprehension, many expressed a sense of incompleteness in their understanding. Nevertheless, they expressed a willingness to integrate such activities into their teaching practices, highlighting their potential to enhance conceptual understanding and student engagement in physics education.

Introduction

One of the key components of effective physics teaching is being counted as a teacher who has good subject knowledge, pedagogical knowledge, pedagogical content knowledge, and positive subject attitudes. The attitudes of science educators concerning physics teaching are notably influenced by challenges encountered in physics instruction, particularly those stemming from deficiencies in subject knowledge. An investigation [1] revealed that 39% of science teachers acknowledged the impact of struggling with the teaching of physics concepts on their overall attitudes toward teaching the subject. The science teachers held the view that while the content of the physics course isn't inherently complicated, effectively teaching the physics subjects poses a challenge for them [2]. It would be more complex for science teachers who are not good at understanding physics concepts to teach physics effectively.

It was summarized in the discussion of a work group [3] that focused on different aspects of experiments and laboratory work in teacher education and mentioned that “teachers should be taught the way they are expected to teach” (p. 4). Consequently, as faculty members, we would better create a learning environment for pre-service science teachers to be involved in active learning in labs. That means we must train science teachers, especially for physics content, by supplying them with active engagement, as we expect them to provide adequate space and time to their students and take responsibility for experimenting. Accordingly, this study aims to implement hands-on activities on inertia that facilitate pre-service science teachers who are low achievers in physics to not only comprehend inertia but also discover how to make students involved in active learning by asking the following research questions: RQ1. How do pre-service science teachers who are low achievers in physics perceive the concept of inertia? RQ2. How has their understanding of inertia changed as a result of doing practical work that emphasizes conceptual understanding? RQ3. What do they think about the way students participate in lab work as a result of doing practical work that emphasizes conceptual understanding?

Method

In this case study, implemented in February 2024, 17 pre-service science teachers in the third year of a four-year Science Education Bachelor Degree Program at a state university in the Black Sea Region of Turkey participated. The selected participants, identified as low achievers in physics concepts, engaged in a hands-on activity aimed at assessing their comprehension of inertia and providing an exemplary practice for their future teaching lives. The hands-on activity involved the participants responding to a conceptual question related to inertia, performing two distinct tasks, engaging with a comic clarifying inertia, asking students to replicate the depicted scenario, and finally revisiting the initial conceptual question. Throughout the practical exercises aligned with task performance, participants were guided to articulate predictions, followed by the observation and explanation of observed phenomena concerning their predictions.

The practical component incorporated inquiries into the motion of objects involved in the tasks and the forces acting upon them. Participants were encouraged to pose hypothetical scenarios by formulating "what if..." questions concerning the independent variables (shape, mass, interaction surface) they proposed. This process aimed to enhance their understanding of the resultant effects on the dependent variable, requiring careful consideration of variables, including their manipulation and control. During this practical work, participants were expected to discuss and make decisions in groups, focusing on aspects such as experimental setups and data interpretation. Subsequently, they engaged in group discussions about their trials. Data were collected through group discussions and lab reports detailing their observations, explanations, and answers to conceptual questions (retrieved from FCI [4]) indicating misconceptions about inertia. Additionally, a questionnaire including open-ended questions about the quality of the activity and the level of students' participation was administered. One participant from each group was interviewed on how actively they took part in the hands-on activity.

Findings and conclusion

Pre-service science teachers define inertia as "a tendency to protect motion" (3 groups out of 6) and relate inertia with "friction force" (2 groups out of 6) but most of the participants (11 out of 17) perceive inertia as "a force". It was easy to recall the definition however when they were asked to explain a case related to inertia they described the concept in a different way implying a force that allows the moving object to continue its movement and to stop when it stops. So, as they indicated "an object can only move when its inertia is broken by another force". This suggests that these pre-service science teachers did not have a strong understanding of the concept of inertia.

Based on the questionnaire responses, the pre-service science teachers demonstrated a notable level of interest in the activity, with a majority rating it as highly (9 out of 17) or moderately (8 out of 17) engaging. They indicated a perceived advancement in their comprehension of the concept of inertia (8 out of 17), yet a considerable proportion expressed a sense of incompleteness in their conceptual understanding (12 out of 17). Participants attributed this sense of incompleteness mentioned a preference for the clarification of the theory by the instructor during class sessions, "finishing the deal in the class." Despite feeling incomplete about the activity, participants expressed a willingness to incorporate the activity as a teacher due to its perceived value, ease of implementation, and capacity to stimulate critical thinking and student engagement.

References

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