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Exploring pre-service physics teachers' development of physics identity through the use of Multiple Representations (MR)

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Introduction

What is the value of ‘physics identity’?
It allows us to respond to questions related to social frames for what it means to become a physicist or a physics educator (Johnson, 2016)

What is missing in existing knowledge base?
• What kinds of activities in the classroom practices can influence students’ physics identities (Avraamidou et al., 2020)?
• There is a recommendation to investigate contextual cues (i.e., how the teachers found ways to meaningfully incorporate students’ thoughts and context into the lesson), because this cue appears as a less prominent cue comparing with other cues. (Hazen & Beuteau, 2021)
• What kinds of procedures, processes, contexts, discourses, and interactions supports the enactment of teachers’ identity in science education? (Avraamidou, 2014)

Why do we use multiple representations (MR)?
• An existing literature provides evidence that the use of MR has the potential to enhance students’ conceptual understanding which is directly related to both their competence and performance (e.g. Sara et al., 2017)—essentially how students might see themselves as physics person.

Research Questions

1. Does the use of multiple representations in physics problems support pre-service teachers’ content knowledge about thermodynamics?
2. What is the relation between pre-service teachers’ content knowledge and their physics identities?
3. How does the use of multiple representations influences the development of pre-service physics teachers’ physics identities?

Theoretical Framework

This study adopts a single case study approach with the case being examined by a group of 6 pre-service physics teachers in Indonesia and uses mixed-method for data collection and analysis.

Methods

The design of the study

Data collection and analysis

1. **Phase I**
   - Physics identity questionnaire
   - Students’ content knowledge test
   - Physics identity interview

2. **Phase II**
   - Instruction with Multiple Representations (MR) thermodynamics
     - Three classes (n = 45 students)
     - Four-weeks meeting (2 x 50 minutes lecture meeting in introductory physics course)

   - Physics identity questionnaire
   - Students’ content knowledge test
   - Physics identity interview
   - Survey on the use of multiple representation

   1. Quantitative
      - Physics problems and physical concepts test
      - Thermodynamics Concept Survey (TCS)
      - Semi-structured interview related the physics problems
      - Class observation
      - Physics identity questionnaire
      - Semi-structured interview

   2. Qualitative
      - Participant’s interview
      - Content analysis

   - Data Collection and Analysis Tools

   - Data analysis tool

   - Tool

   - Tool

   - Tool

   - Tool

   - Tool

   - Tool

   - Tool

   - Tool

Discussion and Conclusion

There is a direct correlation between the participants’ content knowledge and how they see themselves as physics persons

<table>
<thead>
<tr>
<th>Item’s number</th>
<th>Sub-topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>MaxT</td>
</tr>
<tr>
<td>7 – 14, 15</td>
<td>MicroT</td>
</tr>
<tr>
<td>22</td>
<td>First law of thermodynamics</td>
</tr>
</tbody>
</table>

The correlation of recognition, performance, competence, and interest with seeing oneself as a ‘physics person’

<table>
<thead>
<tr>
<th>Performance</th>
<th>Recognition</th>
<th>Competence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>0.33**</td>
<td>0.27**</td>
</tr>
<tr>
<td>Post-test</td>
<td>0.34**</td>
<td>0.26**</td>
</tr>
</tbody>
</table>

** indicates significance at p < 0.05

** indicates significance at p < 0.01

• The comparison between the participants’ scores on the pre- and post-test indicates their content knowledge was improved
• Pictorial representations supported the participants to conceptualize the change of macroscopic properties of ideal gases
• Participants faced difficulties in understanding the first law of thermodynamics

References


Discussion and Conclusion

Interest:
"In the beginning, I like mathematics. Then I wonder that mathematics is limited in calculation; it’s not about inventing something. If there is an invention, it will be back to the calculation. This is what I want ("Feynman is doing now). It is not only calculating something but also understanding the nature, how is its characteristics, and how we formulate it.

Recognition:
"They (Refers to his family) are very supportive, especially my third brother. He confess that he represent in this field. Since when we have always discuss about phenomena which is related to physics in daily life.

Performance:
"I join the initiative to explain the phenomena related to fluid flow, although my friends and my teacher contradict with my argument in the end. I feel that it is fine; now I know how it works.

Competence:
"I prefer to use mathematical representation, because I am used to it since I was in school. Learning with other representations should be better and can help me, but I still have difficulties when I find the problem presented in other representations.”