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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 (Johansson (2016)

What is **missing** in existing knowledge base?

- What kinds of activities in the classroom practices can influence students' physics identities? (Hazari et al., 2010)
- There is a recommendation to investigate contextual cues (i.e., how the teachers found ways to meaningfully incorporate students' thoughts and context into the class), because this cue appears as a less prominent cue comparing with other cues. (Hazari & Beattie 2015)
- What kinds of procedures, processes, contexts, discourses, and interactions supports the enactment of teachers' identity in science education? (Avraamidou, 2014)

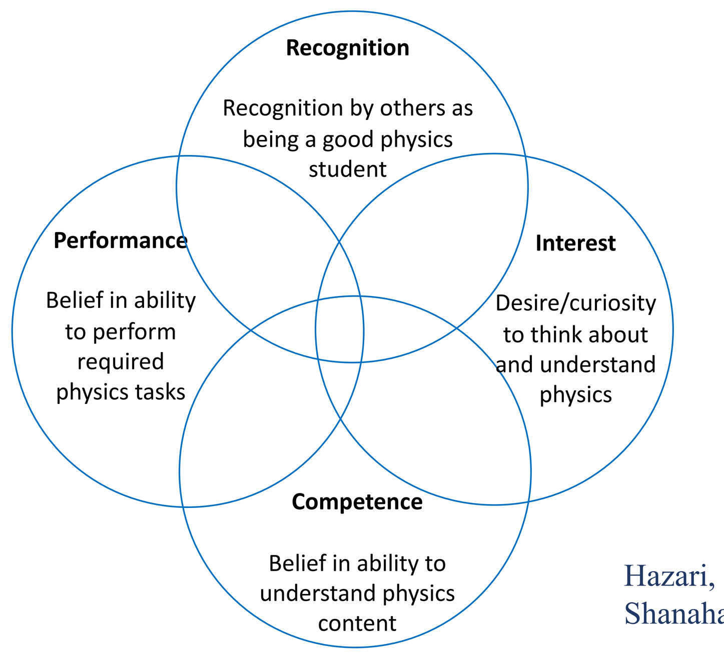
Why do we use **multiple representations (MR)**?

- 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., Susac 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 preservice 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

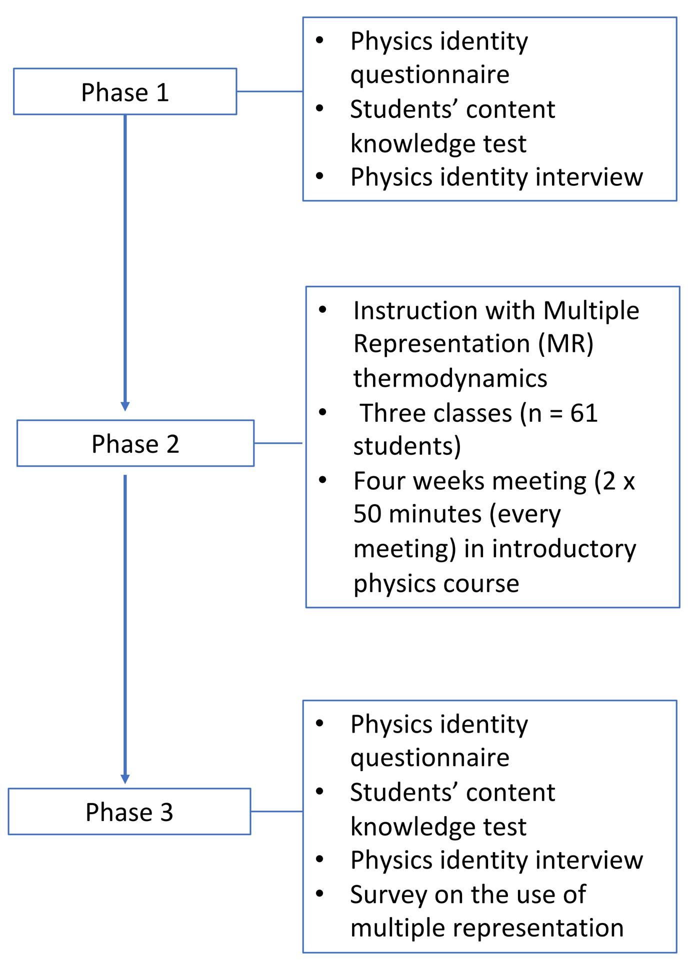


Hazari, Sonnert, Sadler,, & Shanahan, 2010

Methods

This study adopts a single case study approach with the case being defined by a group of 61 pre-service physics teachers in Indonesia and uses mixed-method for data collection and analysis.

The design of the study:



Data collection and analysis

RQs	Methods	Data Collection and Instruments	Data analysis	Tool
1	- Quantitative - Qualitative	- Physics problems and physics concept test - Thermodynamics Concept Survey (TCS) - Semi-structured interview related the physics problems - Class observation	- t-test - Describing the result of semi-structured interview - Describing students' difficulties when they faced problem with multiple representations - Content analysis	SPSS Atlas
2	- Quantitative - Qualitative	- Physics identity (PI) questionnaire - Semi-structured interview	- Correlation between TCS's score and PI's score (after the learning process) - Content analysis	SPSS Atlas
3	- Quantitative - Qualitative/ exploratory	- Physics identity (PI) questionnaire - Semi-structured interview - Classroom observation	- Correlation (i.e. performance, competence, recognition, and interest) and PI' score - The difference between every dimension of PI and the PI score pre- and post-test - Content analysis	SPSS Atlas

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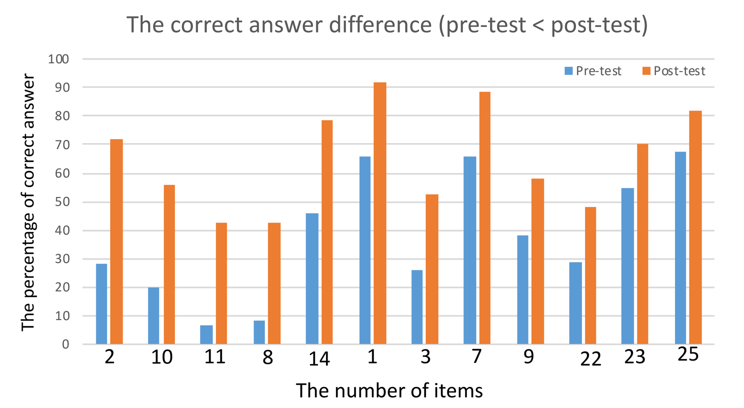
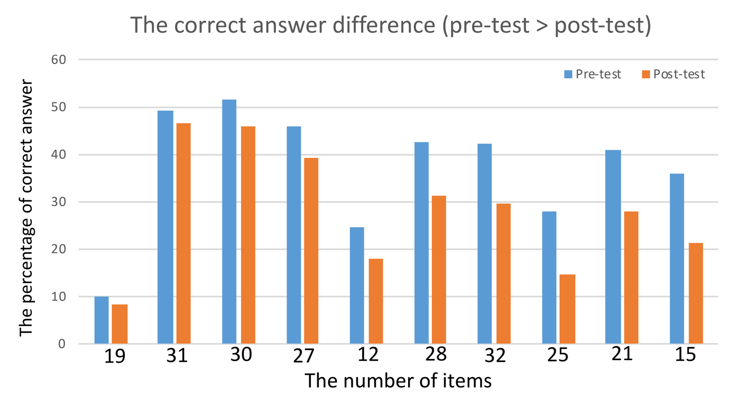
Findings

RQ1

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





Items' number	Sub-topics
1, 2	Temperature
3	Heat exchange
5	Heat transfer
7 – 11, 14	Macroscopic properties of ideal gasses
23	The first law of thermodynamics

Items' number	Sub-topics
12	Macroscopic properties of ideal gasses
15	Thermodynamics process
19, 21, 25, 27, 28, 30-32	The first law of thermodynamics

RQ2

- There is a direct correlation between the participants' content knowledge and how they see themselves as physics persons
- Of the 4 identity components, recognition has the strongest impact on how the participants see themselves as physics person

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

Descriptions	r	Descriptions	r
Performance		Interest	
Teaching others	0,337**	Telling others about science concepts	0,339**
Asking questions	0,166	Explaining things with facts	0,277*
Answering questions	0,269*	Using mathematics	**0,502****
Recognition		Making scientific observations	0,213
Parents/friends	**0,591****	Wanting to know more science	0,141
Teacher	**0,572****	Graduating from college with honors	0,108
Competence		The use of multiple representations	
TCS' score	**0,406****	I am good at figuring out how closely related different representations are (words, equations, pictures, diagrams, etc.)	0,389**
Interest		I often use MR (drawing pictures, diagrams, graphs) when solving physics problems	0,304*
Thermodynamics	0,396**	When I use MR, I do so because it makes a problem easier to understand	0,266*
Conducting your own experiments	0,319*	When I use MR, I do so because I will be more likely to get the right answer	0,360**
Understanding natural phenomena	0,318*	When I use MR, I do so because the instructor (or the book) tells me that I should	0,053
Understanding everyday-life science	0,345**	I am good at representing information in multiple ways to explain it to my peers (words, equations, pictures, diagrams, etc.)	0,466**

* it is significance on $p < 0.05$
** it is significance on $p < 0.01$

RQ3

➢ **Interest**:
" In the beginning, I like mathematics. Then I am wondering 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 (*refers to what he is doing now)*. It is not only calculating something but also understanding the nature, how its characteristics, and how we formulate it."*

➢ **Recognition**:
"*They* (*refers to his family) *are very supportive, especially my third brother. He confess that I am prominent in this field. Since we always have discussion about phenomena which is related to physics in daily life.*"

➢ **Performance**:
"*I take 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*".

Discussion and Conclusion

➢ There is a process of conceptual change based on the correct answer differences of students' content knowledge test. The distinction between knowledge enrichment and conceptual change allows us to view how the different concept learning processes and how each representation plays different roles in that process (Amin and Levrini, 2017).

➢ Recognition by parents and teacher have the strongest correlation with students' physics identity (this result is the same with Hazari's work (Hazari, Sonnert, Sadler,, & Shanahan, 2010)); it means that the important of support and belief of another people can effect students identity (Potvin and Hazari, 2013).

➢ The second strongest component is interest which relates to the use of mathematics; It has been argued that physics involve a lot of formula and mostly correlate with mathematics ability (Nilsen, Angell & Grønmo, 2013). It is also in line with the argument that equation plays a deep role in understanding physics (Feynman, 1965).

➢ The students have a chance to develop their performance, competence, recognition, and interest in physics in which we acknowledge as physics identity through the use of MR as a classroom practice.