Exploring Indonesian preservice physics teachers’ development of physics identity and physics teacher identity
Munfaridah, Nuril

DOI:
10.33612/diss.197985205

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Document Version
Publisher's PDF, also known as Version of record

Publication date:
2022

Link to publication in University of Groningen/UMCG research database

Citation for published version (APA):

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SUMMARY
The construct of identity has been used in educational research to refer to how people see themselves and are recognized by others (Carlone & Johnson, 2007). The development of identity, as well-illustrated in the literature, is a dynamic, complex, and multifaceted process, which is influenced by cognitive as well as social factors. In physics education, preservice physics teachers need to not only develop a strong physics identity as learners of science, but they also need to develop a strong physics teacher identity as future physics teachers. Teacher preparation programs have traditionally focused on goals related to conceptual development and have paid little attention to social and cultural aspects of the process of becoming a physics teacher as for example, aspirations, relationships, and interactions with peers and mentors. Hence, it is important that teacher preparation programs re-design their programs to include goals related to aspects of preservice physics teachers’ development that remain under-addressed. These goals, which go beyond conceptual knowledge related to social positioning, relationships, and interactions, have been explored by researchers through the construct of “identity”.

This thesis studies the development of preservice physics teachers’ identity, both physics identity and physics teacher identity, through the implementation of a multiple representations (MR)-based instructional approach in an introductory physics course in the teacher education program at an Indonesian university. The first year of the program is a critical period in teachers’ development given that the presence of positive learning experiences early in the program is expected to influence preservice physics teachers’ development as a physics student (i.e., physics identity) and a physics teacher student (i.e., physics teacher identity). The MR-based instructional approach is preferable because most physics educators are familiar with using representations in their teaching.

Chapter 2 provides a systematic review on the use of MR in undergraduate physics education. Research evidence showing that an MR-based instructional approach is beneficial for students’ learning and that physics educators are familiar with this approach served as the departure point for this review study. The main focus of this study was to provide an overview of the existing knowledge base, to identify gaps and to propose future research about the use of MR in undergraduate physics education.

For the purpose of this study, we reviewed 24 empirical studies published between 2002 and 2019 from peer-reviewed scientific journals. The selection process was based on specific inclusion criteria (see Chapter 2, Figure 2.1) and the analysis was based on the following aspects of the studies: (a) aim of the study, research questions,
information about the participants; (b) information about the context of the study; (c) how MR were conceptualized; (d) the methods used; and (e) findings. Then, we presented the findings of the analysis, which were grouped under the following five themes (see Chapter 2, Table 2.1): (a) In what ways does the use of MR in instruction support student learning? (b) What kinds of representations do students use? (c) What difficulties do students face in using MR? (d) What is the relation between students’ use of MR and students’ problem-solving skills? and (e) What is the added value of technology integration in teaching with MR? The outcomes of this study showed that MR could serve as an empowering learning tool in the teaching of physics at university, especially in enhancing conceptual understanding and problem-solving skills.

Beyond the synthesis of the findings of the studies reviewed, the study also resulted in identifying gaps in the literature and proposing future research directions: (a) the use of MR in university physics textbooks; (b) blending of different kinds of MR; and (c) the use of virtual reality applications.

**Chapter 3** provides details about the intervention as well as the context of the implementation of the MR-based instructional approach in the introductory physics course on the topic of thermodynamics. The designed intervention was based on empirical evidence that preservice physics’ teachers’ development of conceptual understanding and problem-solving skills will contribute to the development of their physics identity as well.

In this chapter, we provide information on: (a) details on the implementation of the intervention; (b) examples of problems and activities in the classroom; (c) a brief explanation of how the MR-based instructional approach is related to physics identity and physics teacher identity.

In **Chapter 4**, we report on the findings of a quantitative empirical study that aimed to examine whether the use of an MR-based instructional approach exerts influence on preservice physics teachers’ physics identity. In this study, we used a combined physics identity framework proposed by Hazari et al. (2010) and Carlone and Johnson (2007). This combined framework includes four components: (a) competence – actual knowledge and understandings of physics content knowledge, in this case thermodynamics; (b) interest – desire and curiosity to think about and understand physics; (c) performance – belief in own ability to perform physics-related tasks; and (d) recognition – self-recognition and perceived recognition of how one is recognized by others as a good physics student. Specifically, the study aimed to address the following research questions:
1. Does an MR-based instructional approach lead to an increase in preservice physics teachers’ actual competence, performance, interest, and recognition as components of physics identity?

2. Does the use of MR predict preservice physics teachers’ physics identity components?

The participants were 61 preservice physics teachers in the first year of the physics teacher education program in one of the public universities in Indonesia. We examined their physics identity using an adapted version of the physics identity questionnaire from Hazari et al., (2010), and their conceptual understanding through the thermodynamics concept survey (TCS), which was adapted from Wattanakasiwich et al. (2013). In addition, to understand how the preservice physics teachers used some representations in the learning process, we also administered a survey of the use of representations and alongside open questions about their experiences in the course. We analyzed data through a t-test to compare the pre- and post-test of each physics identity component. In order to find the correlation between physics identity components and the use of MR, we performed multiple regression analysis with the score of post-tests of each physics identity component as the dependent variable and the average of the survey of the use MR and pre-test score of the physics identity components as the predictor.

In response to the first question, the findings indicated a significant difference between pre- and post-test scores for two physics identity components, namely competence and interest (see Chapter 4, Table 4.1). However, we did not find any significant difference for the other two components (i.e., performance and recognition). In response to the second question, we found that there is a positive correlation between self-identification with the use of representations and competence and interest. These findings serve as the indication that the use of the MR-based instructional approach might contribute to the development of preservice physics teachers’ physics identity.

In the final study, in Chapter 5, we presented the findings of a qualitative case study that aimed to explore preservice physics teachers’ development of physics teacher identity. Specifically, this study aimed to respond to the question:

- How do preservice teachers develop their physics teacher identities through an introductory physics course that incorporates multiple representations?”
Using the Dynamic System Model of Role Identity (DSMRI) as a conceptual framework (Kaplan & Garner, 2017), we examined 21 preservice physics teachers’ experiences after they participated in the course. The framework consists of four components: self-perception and self-definition, purpose and goals, epistemological and ontological beliefs, and perceived actions and possibilities. Since the participants were expected to become high school physics teachers, we also asked them to elaborate on their teaching philosophies and specifically whether they would consider using the MR-approach when they would teach their future students. The data were analysed using a combination of a priori and in-vivo coding techniques. (see Chapter 5, Table 5.1).

The findings showed that their engagement in the course contributed to preservice physics teachers’ views about teaching and learning physics, which refer to specific components of role identities of becoming physics teachers: (a) purpose and goals (e.g., preservice physics teachers want to be physics teachers who can help their future students getting rid of the negative stereotypes of physics); (b) perceived actions and possibilities (e.g., preservice physics teachers were positive in using the MR-based instructional approach as their strategy in teaching their future students); and (c) self-perceptions and self-definitions (e.g., preservice physics teachers identified themselves with high and low confidence in becoming a successful physics teachers).

In this thesis, reporting the first research on identity development in Indonesian education, we explored the ways in which an MR-based instructional approach in an introductory physics course supported preservice teachers’ development of physics identity and physics teacher identity. The two empirical studies in this thesis use both quantitative and qualitative data in examining the preservice physics teachers’ learning experiences with the use of MR-based instructional approach and how those impacted the development of their identities. Although this thesis is limited in the context, the findings indicate that unique learning experiences with the MR-based instructional approach might contribute to the development of preservice physics teachers’ identities.