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Multimodal Inquiry Learning Framework in Meaning-Making of The Concept of Force

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Abstract

Past studies have shown that the interactions that appear between existing knowledge and new knowledge of students will result in a conceptual change in students. However, the process of conceptual change is complex and requires careful planning by teachers. In this concept paper, the constructed Multimodal Inquiry Learning (MIL) framework introduced the physics topic of force studied by matriculation students in the first semester of their studies. Learning that involves verbal and non-verbal communication is a common feature of multimodal learning. While inquiry learning uses various modes of communication including verbal, visual, pictorial, graphic, and text is called multimodal inquiry learning. Past studies have proven that multimodal representation is found to play a role in the conceptual change for the concept of heat, but how the conceptual change takes place in the student's mind through meaning-making has yet to be explained by them. The MIL framework suggested by this study is expected to help physics teachers/lecturers, especially in improving their pedagogical practices.

Keywords: Conceptual Change, Learning Framework, Physics, Force, Multimodal, Inquiry.

Introduction

The level of global education is seen to be growing in line with the progress of today's modern world. Countries around the world including our country Malaysia, continue to strive to advance their education to a higher level. This aims to prepare the young generation to face the needs of the 21st century, especially in the field of Science, Technology, Engineering and Mathematics (STEM).

STEM education in Malaysia was introduced through the implementation of the Secondary School Standard Curriculum (KSSM) in 2017 (Curriculum Development Department (BPK), 2016). STEM education unifies disciplines that lead to effective and high-quality learning, unifies real-life practices, and encourages individuals to think creatively and critically (Rahayu et al., 2005; Stein et al., 2007; Stohlmann et al., 2012).

The Malaysian Education Development Blueprint 2013-2025 also outlines the desire to produce knowledgeable and highly skilled citizens to face international competition (Ministry of Education (MOE), 2013). This desire has been translated into the physics curriculum, aiming

to produce students who have knowledge and skills in the field of physics to enable them to solve problems and make decisions in everyday life (BPK, 2018).

To produce students with knowledge of physics, effective and meaningful physics learning needs to happen during the teaching and learning (TnL) processes. This effective and meaningful learning will lead to a good understanding of the basic concepts of physics. An understanding of physics concepts is important so that they can be used to solve everyday problems (Ratnasari et al., 2017; Sudarmani et al., 2018). Past studies have also shown that one of the reasons students fail to solve physics problems based on everyday life is due to a relatively weak mastery of physics concepts (Ibrahim & Naim, 2010; Aufa & Nursaila, 2022). This means that the mastery of the basic concepts of physics is a factor that can influence how students apply the physics concepts learned to their daily activities. Therefore, to ensure that the main goals of the physics education curriculum can be achieved, students' understanding of these physics' concepts must be given attention.

However, students are found to have existing knowledge that is not in line with scientific concepts, before they learn the concepts in class (Duit & Treagust, 2003; Hewson & Hewson, 1983; Treagust & Duit, 2008). This existing knowledge makes it difficult for students to understand scientific concepts in class (Treagust & Duit, 2008). Conceptual change is a term used to describe the change in students' alternative framework to scientific concepts because of the learning they experience (Tao & Gunstone, 1999). In this study, the conceptual changes that occur to students after learning physics concepts will also be identified.

Problem Statement

The interaction that exists between existing knowledge and new knowledge of students will produce conceptual changes in students (Hewson & Hewson, 1983; Posner et al., 1982). However, conceptual change in students will only occur after the students' existing concepts are compiled, changed, and replaced with new concepts (Smith et al., 1993). This means that the process of conceptual change in students is complex and requires careful planning by the teacher (Hewson & Hewson, 1983; Mason, 2001; Smith et al., 1993; Mustaffa & Halim, 2016).

Based on previous studies, there are various existing knowledge and alternative frameworks that exist in students before learning the concept of force in class (Tarmimi & Kadri, 2016; Fadaei & Mora, 2015; Bani-Salameh, 2017; Halim et al., 2014; Kamarrudin et al., 2020; Mazlena, 2022; Nie et al., 2019; Normawani & Lilia, 2018; Siti Nursaila & Faridah, 2015; Tao & Gunstone, 1999). The alternative framework that students hold makes it difficult for students to learn and understand the concept of force because the alternative framework students have is difficult to change (Azita & César, 2015; Mason, 2001; Nie et al., 2019). This alternative framework will remain in the minds of students (Bani-Salameh, 2017; Liu & Fang, 2016), especially matriculation students, if not changed, even though the concept of force has been taught since high school.

Changes to this alternative framework require conceptual changes to occur gradually among students (Vosniadou, 2013). Conceptual changes in students during the TnL process also involve communication between teachers and students (Çelik & Kılıç, 2014; Mason, 2001; Mortimer et al., 2012). Communication is divided into verbal and non-verbal (Nor Suhaila et al., 2014). Verbal communication involves similes such as personification, hyperbole, metaphors, thimbles, and so on (Saouma et al., 2018), while non-verbal communication involves body language such as facial expressions, body signals, eye gaze/movements, and the elements of humour (Khairuddin, 2014; Zakaria et al., 2019).

Learning that involves communication that occurs verbally and non-verbally is a general characteristic of multimodal learning. Yelland (2018) defines multimodal learning as the application of more than one mode (multimodal) for learning that offers a variety of rich learning experiences for students. For example, multimodal learning can consist of linguistic (text-based), visual, kinesthetics (digital touch), aural and spatial (movement) modalities. This multimodal learning is often associated with the construction of meaning-making by several researchers (Kewalramani & Veresov, 2021; Tang et al., 2014; Williams et al., 2019).

A study by Diyana (2020, 2018) has proven that multimodal representation is found to play a role in the conceptual change for the concept of heat, but how the change in the concept takes place in the student's mind through meaning-making has yet to be explained by her. This is because meaning-making is the result of communication and interaction between teachers and students through the involvement of multimodal representation (Flood, 2021; Morawski & Rottmann, 2016; Park et al., 2021; Williams et al., 2019). Therefore, this study suggested a framework, called the MIL framework to explain how meaning-making will change the alternative framework of matriculation students in the concept of force.

Conclusion

The main contribution of this study is the contribution to the emergence of new knowledge in alternative framework change by MIL framework. This study was conducted to elaborate new knowledge on this philosophy of social constructivism when the role of multimodal representation through inquiry learning is very rarely elaborated by physics education scholars. This will also open opportunities for further studies after this on the learning of multimodal inquiry on the philosophy of social constructivism.

In terms of contribution to learning practice, the study of multimodal representation through inquiry learning on the changes of alternative framework, will be used to assist students in understanding the concept of force. Teachers can use multimodality and inquiry in their TnL to ensure that they can get to know more deeply the alternative framework of students and then change it to the correct concepts.

The proposed MIL framework as shown in Figure 1 can be studied further in the future by exploring other scientific concepts.

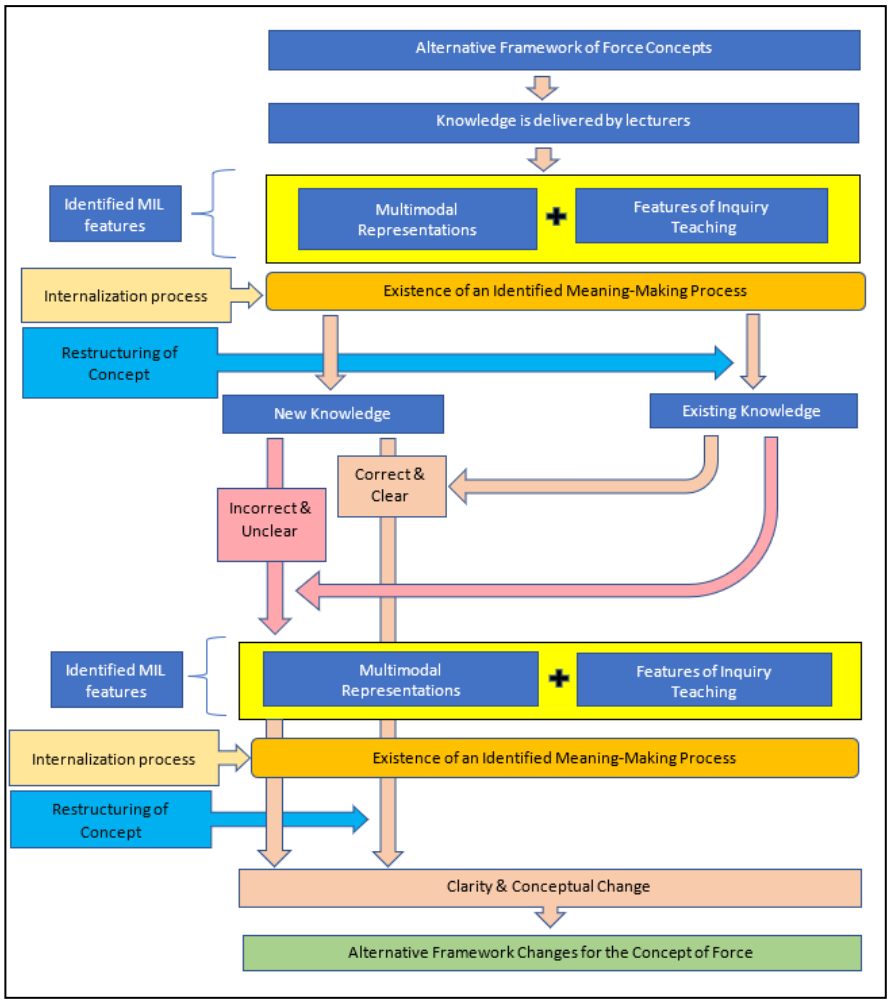

Figure 1. Proposed MIL Framework in Meaning-Making for the Concept of Force

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