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The Role of Hands-on Approach in Overcoming Students' Misconceptions about Matter: A Case Study

¹ Ting Qian Ning, ² Samri Chongo

^{1,2} Department of Science, Institute of Teacher Education, Penang Campus, Malaysia

Corresponding Author: **Samri Chongo**

Abstract

Students' misconception during the teaching and learning of science has always been a great concern for teacher as it gives great impacts towards students' progress in learning science especially when learning abstract concept such as Matter. In order to overcome students' misconceptions, hands-on approach which practice student-centered and active learning experience was applied so that students utilize their senses to learn. This case study was carried out to identify the types of misconceptions faced by students about Matter and to explore how and to what extend is hands-on approach able to overcome students' misconceptions about Matter. Qualitative approach was applied through instruments such as document analysis, observation and interview to collect data based on John Dewey's theory of hands-on approach, Lev Vygotsky's

social cultural theory and Jean Piaget's theory of cognitive development. Four students were selected from a school at Penang as samples of the research through non-probability purposive sampling technique. The findings of the research shows that there were several types of misconceptions faced by students about Matter which include misconception about the properties of matter, arrangement of particles, heat gained or heat lost during the changes in states of matter for water, changes in states of matter for water, formation of water droplets during condensation and formation of cloud. Moreover, there were several aspects about how and to what extend is hands-on approach able to overcome students' misconceptions about Matter. The findings of the research have provided positive implications towards science teacher, students and researcher.

Keywords: Misconceptions, Hands-On Approach, Matter

1. Introduction

Learning by doing plays an important role in the teaching and learning of science in order to improve students understanding and to help students to develop useful skills for professional dan personal development (Matias & Springs, 2020) ^[13]. According to Jessani (2015) ^[9], "chalk and talk" method will discourage students from learning science which leads to misconceptions. Therefore, hands-on approach which suggests children to learn by doing is crucial in the teaching and learning of abstract concept such as Matter which often causes misconceptions among students especially on the arrangement of particles and states of matter (Niroj & Srisawasdi, 2014) ^[16]. However, according to Nik Azmah *et al.* (2014) ^[15], Malaysia teachers find it difficult to integrate scientific thinking skills in science lesson which then contribute to misconceptions among students. Therefore, a case study was carried out to identify the types of misconceptions faced by students and to explore how and to what extend is hands-on approach able to overcome students' misconceptions about Matter. Mageswary Karpudewan *et al.* (2017) ^[12], identifying and addressing misconceptions were crucial to determine the effectiveness of teaching and learning of science to prevent it from worsen with time. In this research, hands-on approach was applied in the teaching and learning of Matter with Year Five students through various interesting hands-on activities to help them to overcome their misconceptions about Matter. This is because according to National Science Teaching Association (2014) ^[14], students involved themselves in planning, testing, observing, recording and presenting their findings which therefore helping them in overcoming their misconceptions.

According to Williams (2017) ^[19], John Dewey's theory of hands-on approach emphasizes on the importance of learning by doing by insisting that learning must happens through experience of reality. Environment plays a major role in the learning process as they interact with the environment which allows them to relate current knowledge to prior experiences. This is supported by Khasawneh *et al.* (2014) ^[10] who states that John Dewey suggested teacher to play the role as facilitator by Hence, allowing students to figure out the concept in groups through conversation, discussion and collaboration. Social interaction which is highlighted in Lev Vygotsky's social cultural theory was focused in this research as scaffolding of teacher,

questioning and discussion between teacher and students and sharing of ideas among students enhances the learning process (Abtahi, 2018) [1]. Throughout the learning process, Piaget's Theory of Cognitive Development portrays as assimilation and accommodation happens. Moreover, the importance of hands-on approach is further highlighted as according to Piaget (1983) as cited in Lefa (2014) [11], students at the age of 7 to 11 years old are at the concrete operational stage. Therefore, teacher should implement concrete hands-on experiences to help students to assimilate previous knowledge with new knowledge.

Misconceptions are alternative conceptions or conceptual difficulties that is formed by students in order to help them to understand the scientific concepts. According to Baydere (2021) [4], it is often incorrect and it varies from individual to individual when they predict, observe and explain during the learning process. According to Dani *et al.* (2020), context-based hands-on approach does reduce students' misconceptions on science subjects as they conduct scientific process through physical experience. This is further supported by Chen (2020) who found that teaching strategy which involves hands-on approach does help students in connecting their scientific conceptual knowledge. These confirms that hands-on approach enables students to reconstruct and overcome their misconceptions. Learning poses challenges during pandemic Covid-19 as classes were conducted online in a lecture style. Hence, this highlights the importance of learner-to-learner engagement during hands-on approach in building an active learning community which then encourages learner-to-content engagement.

The research focuses on determining the types of misconception faced by students about Matter after researcher's experience during practicum and based on researcher's analysis towards findings of past studies which highlighted the issues of students' misconceptions about Matter. By carrying out document analysis, researcher identified several types of misconceptions of students about Matter. Moreover, this case study also focuses on how and to what extend is hands-on approach able to overcome students' misconceptions about Matter. Hence, researcher focuses on exploring the aspects of hands-on approach that contributing to the ability of hands-on approach in overcoming students' misconceptions about Matter through interviews and observations towards research participants.

2. Research methodology

2.1 Research Design

The research design used is case study. Qualitative approaches were used in this case study through instruments such as document analysis, observation and interview to identify the types of misconceptions faced by students about Matter and to explore how and to what extend is hands-on approach able to overcome students' misconceptions about Matter.

2.2 Sampling

Non-probability sampling technique through purposive sampling was carried out to select samples for the research. Four Year Five students were selected as research participants through document analysis on students' worksheets.

2.3 Research Instruments

Table 1: Summary of data collection methods according to research questions

S. No	Research Questions	Instruments
1	What are the types of misconceptions faced by students about Matter?	Document Analysis
2	How and to what extend is hands-on approach able to overcome students' misconceptions about Matter?	Observation Interview

The research instruments used in this case study were document analysis, observation and interview. Document analysis was carried out by analysing students' worksheets on Matter to identify students who faced misconceptions on Matter. Observation and interview were carried out to explore how and to what extend is hands-on approach able to overcome students' misconceptions about Matter. Observation was made during the teaching and learning of Matter through hands-on approach using observation checklist. Structured interview was carried out and recorded through Google Meet using open-ended questions towards each research participants after the teaching and learning of Matter.

2.4 Validity and Reliability

The worksheets, observation checklist and interview questions given were checked by supervising lecturer and teacher to ensure that the items were able to answer research question. Structured interview was carried out with consistent sequence of questions. Pilot study was carried out towards other students of similar age to ensure that the interview questions asked were suitable to research participants' language level. Interview session was recorded and transcript was produced for accurate analysis and interpretation. Triangulation method was applied whereby findings from document analysis, observation and interview were used to confirm and verify each other findings about the role of hands-on approach in overcoming students' misconceptions about Matter.

2.5 Data Collection Procedures

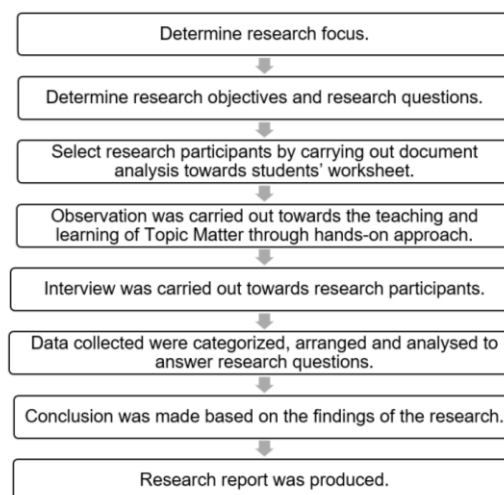


Fig 1: Data collection procedures for the research

2.6 Data Analysis Procedures

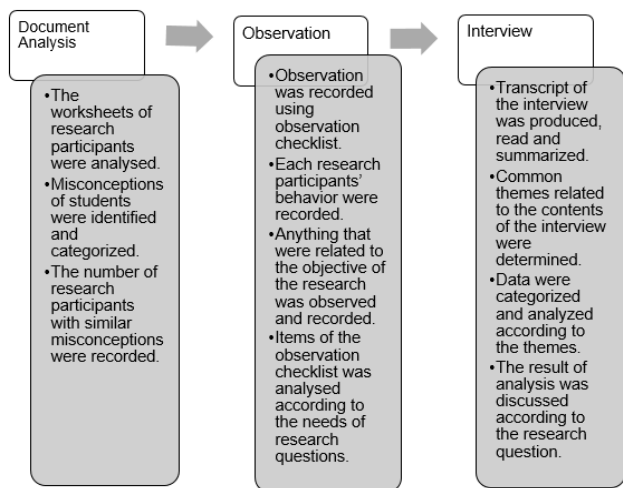


Fig 2: The data analysis procedures for the research

3. Findings and Discussions

Research question 1: What are the types of misconceptions faced by students about Matter?

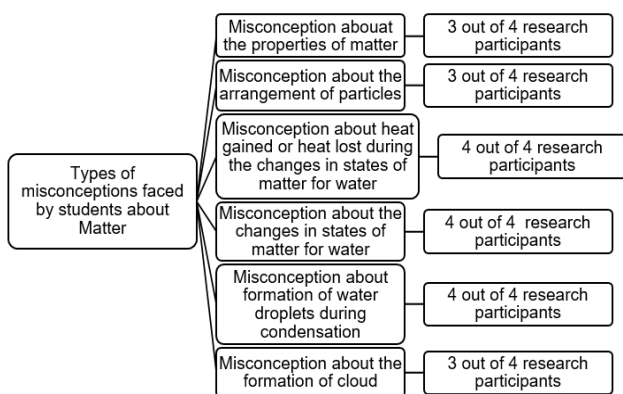


Fig 3: Six types of misconception faced by research participants about Matter and the number of research participants that have misconceptions

Students were found to face misconception about the properties of matter. They had misconception that volume of liquid is determined by the height, shape and size of the container. Language was found to cause students' misconceptions as supported by Holloway (2019) [8]. Students had difficulty to differentiate the arrangement of particles for solid, liquid and gas. They can hardly recognize or visualize the differences between the movement and arrangement of particles in liquid and gas. Students have misconception that regular arrangement of particles symbolize the arrangement of particles in solid (Niroj & Srisawasdi, 2014) [16]. They were confused by the concepts of temperature and heat that cause them to be unable to comprehend the concept of heat gained or heat lost as stated by Yeo *et al.* (2020) [20]. Students were unable to identify or describe the changes in states of matter for water. Students tend to describe based on what they see resulting in misconception about the surrounding states of matter (Baydere, 2021) [4] (Holloway, 2019) [8]. Students were confused about how condensation happens and the scientific terms to describe condensation in Chinese language. Hence,

Mother Tongue should be used during hands-on activities to overcome this language barriers to prevent misconceptions (Cyparsade & Auckloo, 2013) [6]. Students assumed that cloud is formed due to evaporation and thought that cloud is gas. They were confused about the phrases "freezing" and "condenses" proving that language support and additional supports should be given for students to master the scientific terms during the process of learning science concepts (Oyoo, 2015) [17].

Research question 2: How and to what extend is hands-on approach able to overcome students' misconceptions about Matter?

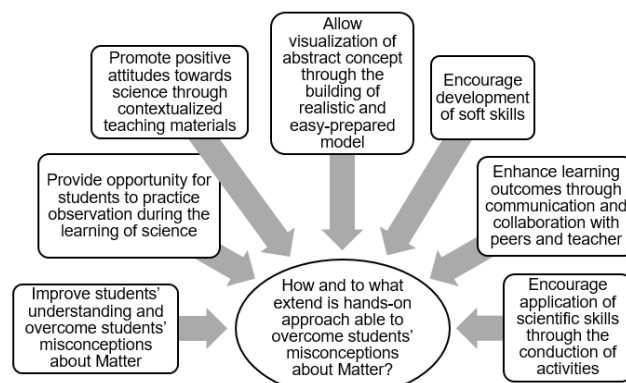


Fig 4: Aspects on how and to what extend is hands-on approach able to overcome students' misconceptions about Matter

Students' misconceptions about Matter from the aspects of mass, shape, volume and space occupying was overcome according to observation and interview. They were able to give detailed scientific explanation about concept learned through their experiences during hands-on activities. They experienced changes in preconceived ideas and their critical thinking skills were enhanced. Observation during hands-on activities improve students' concentration and attention about objects and situations. (Bensusen, 2020) [5]. Students were able to notice differences and similarities of scientific phenomenon and were able to relate observation with the abstract concept learned. Conceptual change happens and students' misconceptions can be overcome (Barke, 2013) [3]. Hands-on approach promotes positive attitudes through contextualized teaching materials. Students used home-based materials which help to expand their learning context (Suryawati & Osman, 2018) [18]. Building of realistic and easy-prepared model allows students to visualize abstract concept. This increases students' interest, motivation, attention and scientific process skills as they manipulate the model and helps in overcoming their misconceptions. (Hirca, 2013) [7]. Students gain soft skills by acquiring the ability to carry out autonomous learning and practice innovative thinking skills to make independent decision when they were asked to find suitable materials from their home. Students manage time by planning and carrying out activities in their own pace allowing them to overcome their misconceptions. Communication and collaboration during hands-on activities allows the exchange and sharing of knowledge. This helps to stimulates mental functions and development through reflections and immediate feedback (Amalia, 2018) [2]. Students acquire scientific skills through hands-on activities by practicing precaution steps showing that students were aware of the scientific concepts involved

in each activity and thus helps in overcoming their misconceptions. This is proven by Hirca (2013)^[7] to be able to enhance students' achievement.

4. Conclusion, Suggestions and Implications

This case study had identified six types of misconceptions faced by students about Matter such as properties of matter, arrangement of particles, heat gained, heat lost, changes in states of matter for water, condensation and formation of cloud. It was found that hands-on approach overcome students' misconceptions about Matter through observation, contextualized teaching materials, realistic and easy-prepared model, development of soft skills, communication and collaboration and application of scientific skills. Suggestions for improvement for further study are to choose more samples from different classes or levels to increase reliability and validity. It is also suggested to include teacher as research participants because teacher is more familiar with students' behavior and misconceptions. This research has brought several implications. It provides solutions for educators to focus on overcoming the types of misconceptions of students about Matter identified using aspects of hands-on approach. Students were able to identify his or her misconceptions through this research. Researchers gain new insights about hands-on approach and can utilize the knowledge about the role of hands-on approach to overcome students' misconceptions about Matter for further study in collaboration with other theories of learning to enhance the teaching and learning of science.

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