Faculty of Cognitive Sciences and Human Development

FORM FOUR STUDENTS' REPRESENTATIONAL FORMAT AND UNDERSTANDING OF THE MOTION OF TICKER TAPE

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Final Year Project Report ☐

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FORM FOUR STUDENTS' REPRESENTATIONAL FORMAT AND UNDERSTANDING OF THE MOTION OF TICKER TAPE

CELESTEA ANAK GERUNSIN

A dissertation submitted
in partial fulfilment of the requirements for the degree of
Master of Science (Learning Sciences)

Faculty of Cognitive Sciences and Human Development
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(2019)

The dissertation entitled **Form Four Students' Representational Format and Understanding of the Motion of Ticker Tape** was prepared by Celestea anak Gerunsin and submitted to the Faculty of Cognitive Sciences and Human Development in partial fulfilment of the requirements for the degree of Master of Science (Learning Sciences).

It is hereby confirmed that the student has done all the necessary amendments for examination and acceptance.

(DR. PHILIP NULI ADING)

Date: 16/05/2019

Grade
A

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Representational format refers to various ways to represent a concept or problem. This study attempted to determine students' representation and understanding of the motion of ticker tape. A total of 24 Form Four science students with a mean age of 16 years old from an urban all-girls' premier secondary schools in Kuching, Sarawak participated in this case study. Data were collected from an instrument, which is document text based on their observation on individual experiment related to ticker tape, namely the exercise of the motion of ticker tape. Content analysis was carried out using coding method using Microsoft Excel. Findings showed students with a high level of learning ability used multiple representations of more than one clear and labelled diagrams of trolley on a runway and also diagram of ticker tape with explanations on the motion of the trolley as well as the distance between dots compared to both the medium and the low groups. They gave scientific explanations of the motion of the trolley with explanation of the distance of ticks supported by diagrams drawn. Meanwhile, most students of average and low level of learning ability which also used multiple representations gave alternative understanding of the motion of ticker tape, due to misconceptions and incomplete explanation made by these students. Only a small number of average and low group students that used single representation in representing their understanding. Based on the overall results, a model of Form Four Students' Representation Format and Understanding of the Motion of Ticker Tape is constructed whereby it can be to help as well as improve teachers' preparation of materials, instructions and learning methods for students' learning in this topic.

ABSTRAK

Format perwakilan merujuk kepada pelbagai cara untuk mempersembahkan atau mewakilkan suatu konsep atau masalah. Kajian ini cuba untuk mengenalpasti format persembahan dan kefahaman pelajar dalam gerakan pita detik. Sejumlah 24 orang pelajar Tingkatan Empat aliran sains yang berumur16 tahun daripada sebuah sekolah perempuan premier di bandar bertempat di Kuching, Sarawak mengambil bahagian dalam kajian ini. Data dikumpul dengan menggunakan instrument dokumen teks berdasarkan pemerhatian pelajar dalam eksperimen individu berkaitan pita detik, iaitu, latihan berkaitan gerakan pita detik. Analisis kandungan telah dijalankan dengan menggunakan kaedah pengkodan menggunakan Microsoft Excel. Dapatan kajian menunjukkan pelajar yang mempunyai tahap pembelajaran yang tinggi menggunakan pelbagai jenis perwakilan iaitu lebih dari satu jenis gambarajah troli atas landasan yang berlabel, dan juga gambarajah pita detik bersama dengan penerangan berkaitan dengan gerakan troli dan jarak antara titik pita detik, jika dibandingkan dengan kumpulan sederhana dan rendah. Mereka memberikan penerangan secara saintifik berkaitan gerakan troli dan jarak titik pita detik, dan berdasarkan gambarajah yang dilukis. Manakala, kebanyakan pelajar-pelajar yang sederhana dan lemah yang juga telah menggunakan pelbagai perwakilan atau persembahan telah memberikan penerangan secara alternatif berkaitan gerakan pita detik, disebabkan oleh salah konsep dan penerangan yang tidak lengkap dilakukan oleh para pelajar. Hanya segelintir kecil sahaja pelajar tahdp sederhana dan rendah yang menggunakan perwakilan tunggal. Berdasarkan keseluruhan dapatan kajian, model Format Perwakilan dan Pemahaman Mengenai Pergerakan Pita Detik bagi Pelajar-pelajar Tingkatan Empat telah dibina di mana ianya dapat membantu dan memperbaiki persediaan bahan mengajar, arahan dan strategi pembelajaran untuk para pelajar mempelajari topik ini.

CHAPTER ONE

INTRODUCTION

Malaysia's vision to become a developed nation by the year 2020 has placed science and technology as important subjects to excel in. This is especially so since science and technology are often perceived as fundamental forces behind economic development in industrialized countries (Lee, 1989). To realize the 2020 Vision and the National Science and Technology Policy, the Malaysian Ministry of Education (MOE) has launched a mission to ensure that the student ratio in Malaysia will be 60:40 – to represent 60% science stream and 40% arts stream students in the upper secondary school, since the year 1994 (Mok, 2008). The main reason of this 60:40 policies is to encourage more science students to participate in the field of health work, engineering, science education, ICT and others science related courses. The MOE was optimistic that this policy can be reached by the year 2010 by early exposure of incorporation of science and technology curriculum (Saleh, 2014). However, in most of the schools in Malaysia, the number of students learning science subjects is still far behind the targeted figure. This matter serious for physics especially which has a very major role in science and technology (Ekici, 2016). Physics result in Malaysia had increased over the years in term of its passing percentage. There is an increase in performance in this subject in 2017 compares to 2016 (Shahar, 2018).

The physics performance in Sarawak too had increased in 2017 as compared to 2016 (Shahar, 2018). However, based on the analysis done by JPNS this year, the number of students that scored A were few compares to grade B, C, D and E as shown in Figure 1.1.

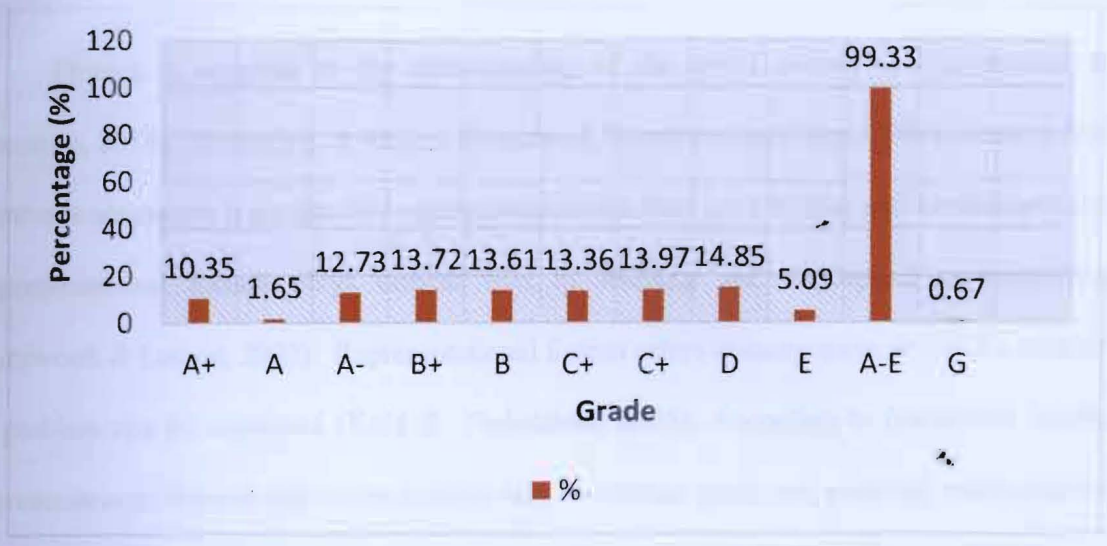

Figure 1.1 *Physics SPM 2017 Result in Sarawak*

This research study will be carried out in one of an urban female school in Kuching, Sarawak with a population of 622 students overall, with four science stream classes. Figure 1.2 shows the physics SPM grade's percentage for the year of 2017 (analysis made by school examination secretary). The mode grade for physics SPM 2017 is D while grade A shows lowest number of students.

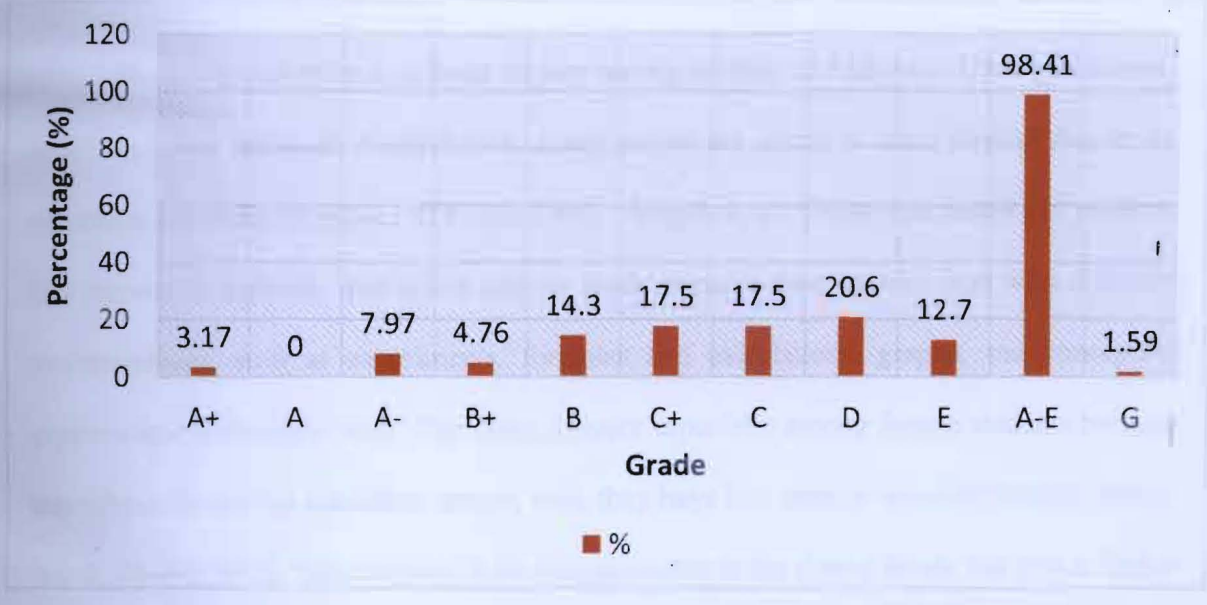

Figure 1.2 *Physics SPM 2017 Result in a Female School in Kuching*

Physics is essential to the understanding of the world around us (Agommuoh & Ifeanacho, 2013). According to Angell, Guttersrud, Henriksen and Isnes (2004), learners find physics is not easy to learn due few representations that they have to deal with simultaneously. Representational format plays critical role in learning and conceptual understanding (Ainsworth & Loizou, 2003). Representational format refers to many ways in which a concept or problem can be expressed (Kohl & Finkelstein, 2005). According to Guttersrud (2008), representational formats can be break down into five forms; graphical, pictorial, mathematical, conceptual and experimental. In this case study, the conceptual representation is divided into written text and verbal. In addition, an experiment is carried out due to its function as the representation of the motion of ticker tape.

In Malaysia, it has been found that the level of educational achievement in the subject of Physics is deemed somewhat less satisfactory (Saleh, 2014). Although the percentage of students who passed the Physics paper in the Malaysian Certificate of Education (MCE) examinations has increased over years, student achievement in terms of overall subject performance in Physics is yet to be proud of. Students, on the whole, have not been quite able to excel in the subject of Physics.

Physics is said to be a difficult subject among students in Malaysia (Utusan Malaysia, 2009) including Sarawak. Nevertheless, many people are afraid to learn Physics due to its reputation as a difficult subject (O'Keefe, 1997). Angell *et. al.* (2004) concluded that students find physics is difficult, that is not easy to learn, because they have to deal with different representations, such as experiments, formulas and calculations, graphs, and conceptual explanations at the same time. This issue is major especially among female students because this subject favour the masculine nature, thus, they have low attitude towards physics (Veloo, Nor & Khalid, 2015). This concern is not only prevalent at the school levels, but also at higher learning institutions such as colleges and universities. An alarmingly high number of students

have also been found to refrain themselves from taking any Physics-related courses at higher levels of education. Students have to deal with various types of representations, and conceptual explanations at the same time (Angell *et. al.* 2004). Fredlund, Airey, and Linder (2012) addressed on students using inappropriate representation in interpreting physics concept.

Few studies have been done on students' representational format, and mostly conducted in the western countries and involved both male and female students (Kohl & Finkelstein, 2006; Sim & Daniel, 2014; Chanijani, Klein, Bukhari, Khun & Dengel, 2016; Gunpinar & Pape, 2018). Sim and Daniel (2014) research focused on students' representation competency at western country. Gunpinar and Pape (2018) study focused on university students only. Meanwhile, Chanijani *et. al* (2016) research focus is limited to vectorial, data tables and diagrams only. However, in a study done by Kohl and Finkelstein (2006), teacher provided representational tool to the students in determining the relationship between students' performance on physics problems and problem representation. Thus, there is a need to investigate in-depth description of students' understanding especially in Sarawak using representational format from their own generated representation from hands-on experiment.

Literature Review

Physics Learning

Physics is a fundamental science that studies the natural phenomena of the world around us which deals with matter, energy, motion, and force. Learning Physics is essential because this knowledge underlies the physical universe and its concept and principles applies into our daily lives (O'Keefe, 1997). Physics, which involve process as well as a structure, mainly study solutions to the problems of 'what', 'why' and 'how' (Sjøberg, 2007) natural phenomena in daily life happens.

In Malaysia, it has been found that the level of educational achievement in the subject of Physics is deemed somewhat less satisfactory (Saleh, 2014). Saleh (2014) also stated that, although the quantity of students passing physics increased over the years, the quality of the overall physics achievement is still yet to be proud of. Similarly, most students find physics a difficult subject and unappealing, whereby this concern not only prevalent at higher learning institutions, but also at the secondary school levels (Saleh, 2014; Snetinova & Koupilova, 2012; Gosling, 2004; Ekici, 2016; Alias, Siraj, DeWitt, Attaran & Nordin, 2013; Saleh & Subramaniam, 2018) especially among female students (Veloo *et. al*, 2015; Simpson & Oliver as cited by Kahle & Meece, 1994; Weinburgh, 1995). Veloo et. al (2015) stated that females don't really favour physics because of its masculine characteristics. Similarly, according to Simpson and Oliver (1990) as cited by Kahle & Meece (1994) and Weinburgh (1995), female students tend to have more negative attitudes towards physics compares to males.

'Kinematics' and 'Dynamics' are said to be the most challenging topics for Physics students (Daniel, 2004). Therefore, to mitigate this problem, it is essential to identify the source of these difficulties as well as ways to overcome this problem.

Learning Difficulties in Physics

Previous research shows that many students still having difficulties in understanding physics concepts which also occurs in Malaysia where by the students having issues in mastering physics and they assumed that physics is an abstract subject that they cannot relate to it (Abdullah Nor, 1998). Angell *et. al.* (2004) infer that students is difficult, because they have to deal with different representations conceptual explanations at the same time. Therefore, many efforts have been done to investigate and find solutions to this issue (Snetinova & Koupilova, 2012; Gosling, 2004; Alias *et. al.* 2013; Saleh & Subramaniam, 2013). Snetinova and Koupilova (2012) in their quantitative and qualitative study found strategies and methods that students mostly used in physics problem solving tasks, and the most strategies used was *Rolodex equation matching.* While according to Gosling (2004), one of the way to decrease physics difficulties in learning among students is by creating cooperative and female-friendly classroom environment, so that everyone can enjoy physics lesson. According to Alias *et. al.* (2013) in their research, found that the usability of physics module in secondary school is significant and hence gives positive impact to the students where it gives space and chance to students to choose their learning styles, help students to understand physics abstract concept, it is practical and interesting, helps to enhance students' ICT skills and therefore, students like physics more. Similarly, also focused on the use of innovation or tools, Saleh and Subramaniam (2018) in their research study proved that the Brain-Based Teaching Method (BBTM) is significantly more effective compared to conventional teaching method in enhancing physics achievement among students. Basically, these efforts that helps in overcoming learning difficulties in physics often related to students' conceptual understanding and reasoning.

Students' Understanding on Physics Concept

There are studies which related to science conceptual understanding. Sands and Raine (2014) emphasizes that students who understand a science concept in a situation given, might fail to reason that particular science concept. Inraine this study, students' understanding on the motion of ticker tape concept is investigated. Nguyen, Gire and Rebello (2010) in their study found that students experienced misconceptions and misuse of physics principles and concepts. This issue is crucial whereby there is a need for studies that investigating or related to students' physics understanding before finding appropriate or suitable solution for this problem. According to Mahmoudy (2008), students are not able to understand and use a concept correctly in physics problem solving due to insufficient knowledge on that particular physics concept. Sometimes, students that has knowledge on a physics concept cannot express their understanding in words and this leads them to difficulties during problem solving. In addition, there are students that do not give enough scientific reasoning and explanation in their answers during solving physics problems. Therefore, the development of students' representational skills is vital as it is a main component of fundamental sense of scientific literacy (Yore, Pimm, & Tuan, 2007), to make sense of science concept. Similarly, Sutopo and Waldrip (2014) also argue on the need of representational approach in learning physics, where students generate their own representation based on the interpreted science concept which contributes in influencing students' understanding and reasoning ability. Hence, this approach will be adopted in this study where students' understanding on the motion of ticker tape is determined with the use of students-generated representation.

Students' Representational Format on Physics Concept

One of the key for learning physics is the ability to use representations (Kohl, Rosengrant & Finkelstein, 2007). According to Kohl and Finkelstein (2005), representations can be categorized into formal or informal, abstract or concrete, or text-based versus graphics-based and more. Classification of various representations among students of a classroom is important in physics learning because it helps teacher to prepare activity and materials based on different level of learning abilities. In this study, students' various representation on the motion of ticker tape is determined and is classified into different types of main and specific representations. Chanijani, Klein, Bukhari, Kuhn and Dengel (2016) in their study found that students of different skill level prefer various representations in solving problems. In addition, it can be distinguished by the amount of representation use. Students of different learning ability will construct different types of representations and this somehow leads to either great or low performances. In this case study, students' most preferred type of representation format will be determined and comparison with other representations is done. Similarly, Goolkasian (2000) found that the use of diagrams in representation gives greater performance compared to text. Carney and Levin (2002) too implied that the use of diagrams or pictures is more effective due to the relationship that can be made and seen among explicit elements and able to produce concise information by summarizing important concepts and points. This highlighted information on a concept helps students' in tackling difficult and complex information. This study is narrowed into more specific information which is the motion of trolley using ticker tape. Kohnle and Passante (2017) argued that analysing, constructing, and translating between graphical, pictorial and mathematical representation of physics concepts is challenging for students. Based on their observation of the experiment carried out and also their result obtained which is the dots produced on the ticker tape, students need to analyse the ticker tape and the

motion of the trolley, and after that they need to construct a representation which shows their understanding of this concept. According to Levin (1981), diagrams or pictures representation can be used as an assistance to students' understanding especially when a problem materials are complex and challenging. Similarly, Kozma and Russel (2005) claimed that representation act as a conceptualizing and reasoning tool. This is important especially in supporting or assisting students in their understanding of a physics concept. In this study, students are required to construct another representation which is of their understanding, based on the representation of motion which is ticker tape. Besides that, Waldrip, Prain and Carolan (2010) inferred that student-generated representation using different representational skills able to give opportunities to the students to express as well as extend their preferred representational skills to demonstrate their conceptual understanding. In this study, students are required to use any types of representations to express their understanding of the motion of ticker tape. Sim and Daniel (2014) in their study found that students' overall level of representational competency had higher dependence on their level of understanding of chemical concepts and their level of understanding of chemical representations. In this research, the focus will be in determining students' representation in a physics concept instead of their competency in representation. Researchers in the education of science claimed that, learners need to understand various representations of science concept and processes, know how to interpret a representation into another representation, and able to coordinate and use it in representing scientific understanding (Hubber, Tytler & Haslam,2010; Prain, Tytler & Peterson, 2009). Thus, representational approach is applied in learning physics, where students generate their own representation based on the interpreted science concept which contributes in influencing students' understanding and reasoning ability (Sutopo & Waldrip, 2014) and encourage understanding in science (Waldrip, Prain & Carolan, 2010). This is essential so that students benefit and gain knowledge by generating own understandings through representations

constructions of their emerging conceptual knowledge using drawing, modeling, discussions, tables, graph, multi-media products, role plays and photographs, in a process of guided inquiry (Ehrlen, 2009). Students who can solve complex problems are those with higher representational ability (Malone, 2008) and students who are good in concepts are those who use representations frequently (Rosegrant, Heuvelen & Etkina, 2009). Students' understanding of a concept depends on the use of students' representation, the amount of representation and consistency in using representation. In this study, students' specific multi-representation is determined and its consistency in every questions is observed. Ainsworth (2008) claimed that the multiple representation plays three main functions in learning; representation complements another representation, using easier representation to interpret difficult representation, to integrate information from multiple representations by constructing deeper understanding. In study done by Sutopo and Waldrip (2014), predominent mode of representation in a study related mechanic topic is mathematical-diagram. However, the most number of representation used will be determined in kinematic topic which is the motion of the ticker tape. This will help to produce quality and better representation. Students can construct new productive representations provided enough time and guidance (diSessa, 2004). However, in this study, students are given limited time to carry out the experiment and constructing representation of the motion of ticker tape without teacher's support. According to Sutopo and Waldrip (2014), it is essential to determine learner's initial understanding through discussion between students and teacher. Finally, Prain & Tytler (2012) argued that students-generated representation improves students' cognitive and reasoning approaches which applicable to science learning through relating with challenges. Hence, it is important to combine students' representation and understanding in a model of students' representation of a physics concept by different level of learning abilities.

Model of students' representation of a physics concept

Students of high level of understanding and representations of a concept had better and higher level of representational competency compared to average and low groups (Sim & Daniel, 2014). Similarly, students of that score high marks in the examination can solve large various of difficult conceptual problems usually are able to represent their understanding in variety forms representations and thus, generate the correct and concise answer (Leonard, Gerace & Dufresne, 2002). Students who used diagram representation has higher mark performance in a subject (Goolkasian, 2000) which means they are of high learning ability group. This is due to their ability to relate a concept and representations generated. In this study, students' specific representation used among high learning ability group will be determined and compare it with low and average groups. Furthermore, study done by Onwu and Randall (2006) found that students that made the relationship between submicroscopic models and macroscopic events was problematic and not entirely straightforward where misconceptions occurred. In this study, besides representation, students understanding also will be determined and classified into two categories; scientific and alternative, of different learning abilities. Finally, Yuanita and Ibrahim (2015) found that learning with multiple representations is more effective in constructing students' mental models in understanding a concept. In conclusion, students' representation and understanding of the motion of ticker tape will produce a modal of students' representation. This is important to enhance and overcome misconception and to give more scientific understanding of the motion of ticker tape. Hence, it is vital to build a model of students' representational format of a science concept, especially, the motion of ticker tape concept which is under the roof of kinematics, to help teacher to provide different learning materials as well as instructions based on different learning abilities, to ensure students construct knowledge and understanding of a science concept.

Conceptual Framework

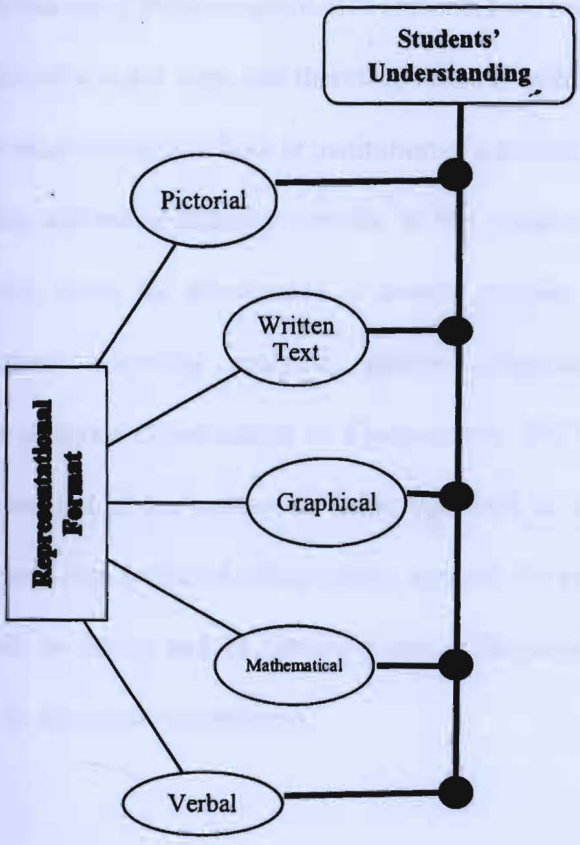

Figure 1.3 *Conceptual Framework of Student's Representational Format of the Motion of Ticker Tape*

Figure 1.3 shows a conceptual framework for this case study. Representational format refers to different methods to represent a concept or problem (Kohl & Finkelstein, 2005). In this case study, students' various representational format such as pictorial, written text, graphical, mathematical, verbal and many more will be used to represent their understanding of the motion of the ticker tape concept. According to Sands and Raine (2014), 'conceptual' implies qualitative reasoning, while understanding, according to Bereiter (2006), refers to psychological process related to an abstract or physical object, such as a person, situation, or message whereby one is able to think about it and use concepts to deal adequately with that