

Faculty of Cognitive Sciences and Human Development

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

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UNIVERSITI MALAYSIA SARAWAK

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

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A dissertation submitted
in partial fulfilment of the requirements for the degree of
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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)

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A

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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.

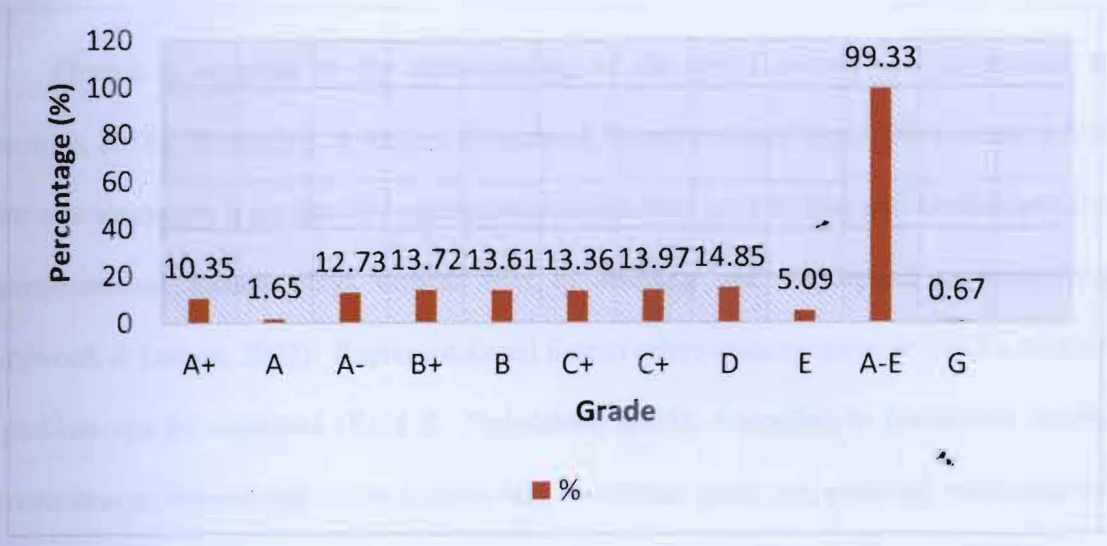


Figure 1.1 *Physics SPM 2017 Result in Sarawak*

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.

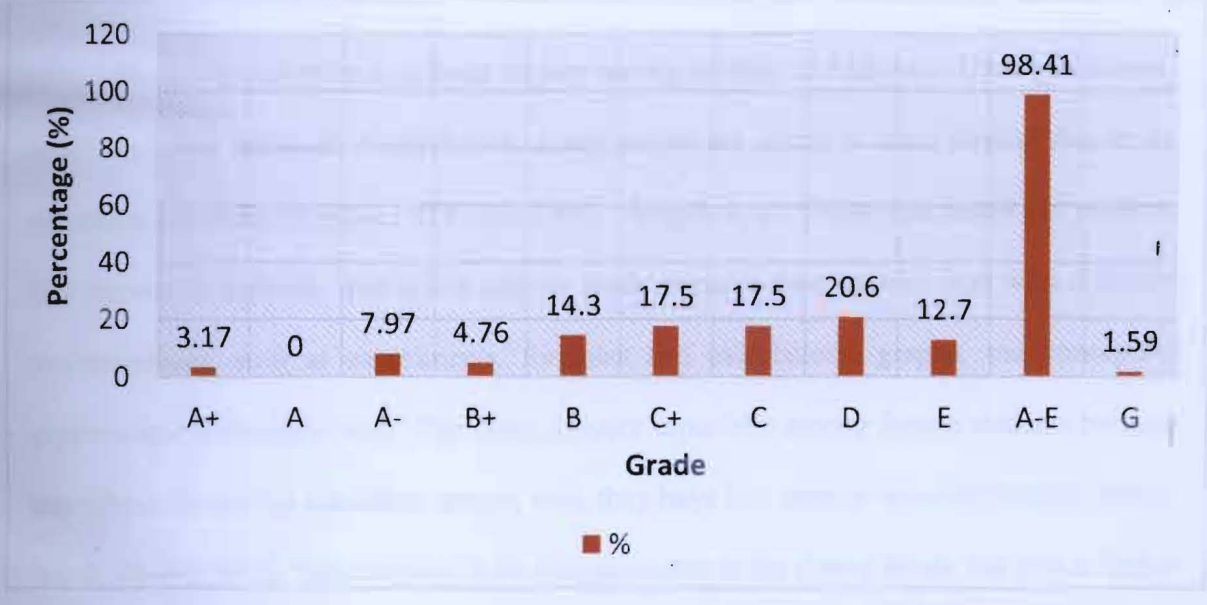


Figure 1.2 *Physics SPM 2017 Result in a Female School in Kuching*

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.

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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

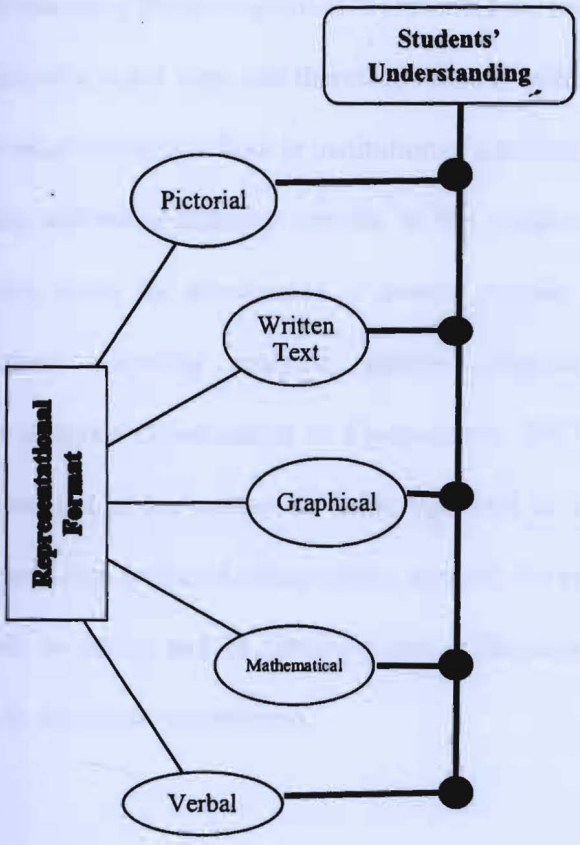


Figure 1.3 *Conceptual Framework of Student's Representational Format of the Motion of Ticker Tape*

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

object, where there is relation between the knower and an object of understanding. Thus, in this study, conceptual understanding refers to qualitative reasoning process that show learner's understanding of the motion of a ticker tape, and therefore relate it with science concepts and hence, a representational format model of school or institution of a subject is crucial in assisting educators to provide better and more effective lessons in the classroom. Representational models refer to "*hypotheses about the distribution of activity profiles across experimental conditions*" which involved encoding analysis, pattern component modelling and representational similarity analysis (Diedrichsen & Kriegeskorte, 2017). Therefore, in this study, a model of representation of the motion of ticker tape will be constructed based on content analysis done towards data collected using coding method, the results pattern for data collected and analysed will be drawn and its similarity and differences of elements of data collected will be encoded in the model constructed.

Research Objectives

Given the outlined above, the main objective of this study is to determine Form Four students' representational format of the motion of ticker tape and its specific objectives are:

a. to determine students' representation of the motion of ticker tape.
b. to determine students' understanding of the motion of ticker tape.
c. to construct a model of students' representational format of the motion of ticker tape.

Limitation of Study

The empirical literature review is limited to year 2009 until now. This study is limited to only female students due to the need to investigate students' representation and understanding among female students only since physics learning among female students because this subject favour the masculine nature, thus, they have low attitude towards physics (Veloo, Nor & Khalid, 2015). Besides that, this case study only involved one school only. This is because we want to investigate in detail and specific students' representation and understanding of the motion of ticker tape. However, it may not precisely generalize to all female students from other schools in Kuching. In addition, this research is limited to only the concept of the motion of ticker tape in linear motion under the roof of kinematics. Further studies can be done for more topics covered and also more challenging topics such as electromagnet and light. It also can be expanded to other science subjects such as chemistry and biology.

Contribution of Study

By doing this research, the knowledge community are able to recognize the importance of students' representational approach in learning and working together in enhancing the practice especially in learning physics. Besides, the organization or school can make use of the finding of the study to find other means to improve knowledge sharing practices. This research also enriches the literature resources in this field especially on the using of representational approach in learning physics. This new finding may also contribute towards the development of existing theory. This study mainly discusses the student-generated representation learning approach in learning physics among secondary school students. Less study has been carried out in Malaysia so far. In addition, this study used qualitative research

methods. The document text used in collecting the qualitative data can serve as a future reference for researchers on the study of representational learning approach in learning physics.

Significance of Study

The outcome of this study will provide a model or overview of students' representational format of the motion of ticker tape concept and also other physics concepts. Hence, this would enhance the development of a new, innovative approach to improve and develop student's representation in understanding a concept. In addition, it will give an insight for educators for lesson planning hence giving equal chance for every student to learn, ensuring academic success.

CHAPTER TWO

METHODOLOGY

This qualitative study aims at investigating form four's students' representational format of the motion of ticker tape which based on their level of learning abilities. Figure 4 shows the flow chart summarizing the research method to determine students' representational format and understanding of the motion of ticker tape. Individual hands-on experiment related to the motion of a trolley using ticker tape is carried out to obtain the dots on the ticker tape. Questions related to the ticker tape are given. Students answered the questions verbally or on a piece of paper, which is a document text. Face-to-face interview was also employed to students who did not provide their initial answer to the questions. This in-depth qualitative research method was carried out since this research study seeks to identify students' representational format as well as their understanding of the motion of ticker tape, and finally construct a model of students' representational format and understanding.

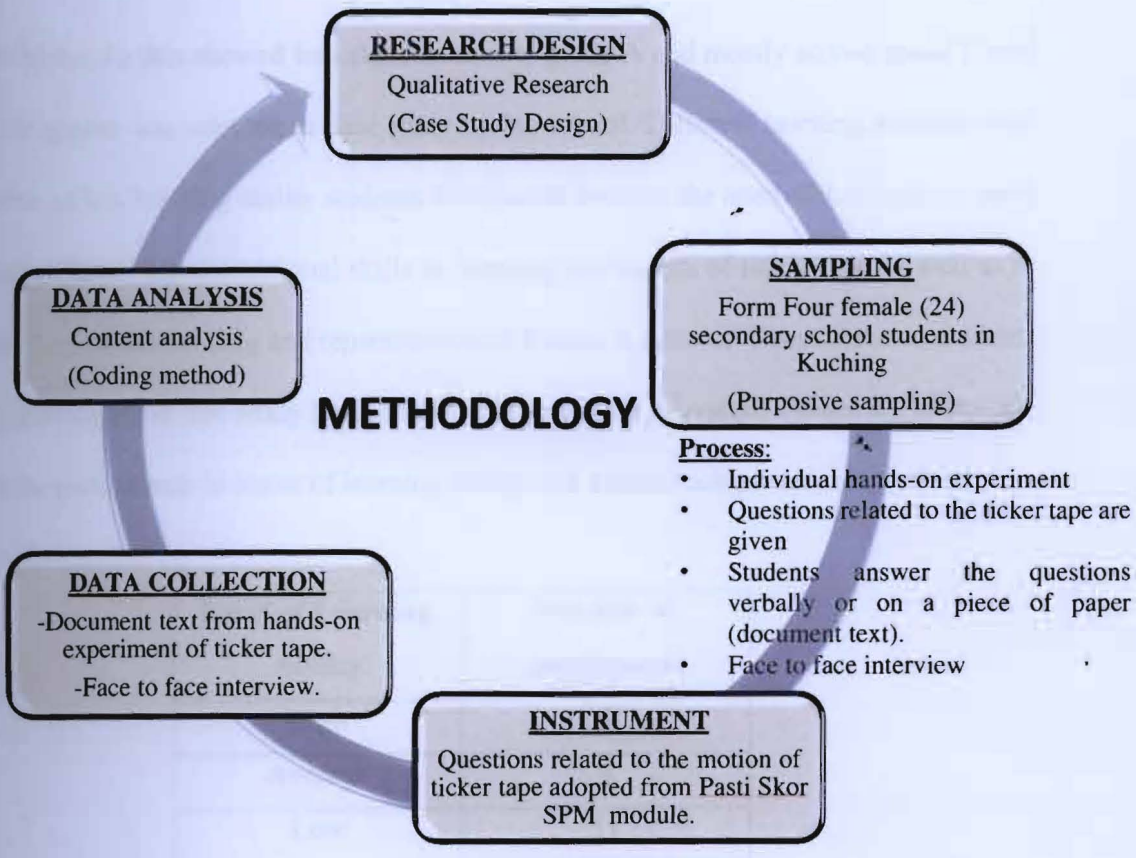


Figure 2 *Flow chart summarizing the research method to determine students' representational format and understanding of the motion of ticker tape*

The Samples

In this study, a representative sample was obtained for the study through purposive sampling due to intentionally chosen participants which comprised 24 of Form 4, that is 16 years old science students from an all-girls secondary school in Kuching, Sarawak with different level of learning abilities. They are categorized into different level of learning abilities based on their formative test performance in physics subject. Form four students are chosen because of the topic they will learn in this level is related to the study; motion of ticker tape, which is under the roof of kinematics. Since the learning difficulties is a major issue especially among female students due to this subject's that favour the masculine nature which leads them to have low attitude towards physics (Veloo, Nor & Khalid, 2015), and also based on previous

physics SPM results that showed less students scored grade A and mostly scored grade D and E, thus, this gender was selected as case study in this school. Different learning abilities with most number of low learning ability students was chosen because the need of this study to build a model of students' representational skills in learning the motion of ticker tape as well as to investigate their understanding and representational format in physics. These selected students willing to participate in this study by filling the consent form provided. Tables 2.1 shows the profile of the participants in terms of learning ability and ethnic background, respectively.

Level of Learning Ability	**Number of participants**
High	4
Average	8
Low	11
Total	23

Table 2.1 *Profile of the participants based on level of learning abilities*

The instruments

Data for the study were obtained from an instrument namely the worksheet of the motion of ticker tape concepts based on participants' observation towards the result of the ticker tape obtained from the experiment carried out. Sample of questions for this worksheet are given in Appendix A.

Worksheet of the motion of ticker tape

This is a paper-and-pencil exercise used to assess students' representation format and understanding of the motion of ticker tape concept, which is under the roof of kinematics. Ticker tape is a representational tool or a material used to determine the motion of a moving object where by a series of dots will be produced on it. This includes velocity, displacement, time taken and acceleration. The dots on the ticker tape is generated from student's individual experiment of the motion of a trolley using ticker timer. From their observation and result of the ticker tape obtained, students described and explained the motion of ticker tape based on given questions on a worksheet. From there, students' representational format and understanding will be determined and analysed. To check for face validity and content-related validity, the initial draft was given to an experienced physics teacher and a lecturer for validation. The questions appeared to be relevant to test students' understanding of the motion of ticker tape.

Data collection

This research will be held from February 2019 to March 2019. The informants will be given a set of consent form and demographic question form to be filled in. Table 2.2 shows the sessions schedule.

Date	**Time and Venue**	**Activity**	**Type of Data collection**	**Participant**
22nd March 2019	2.00 p.m. – 3.00 p.m.	Ticker tape experiment and written test schedule	Document text	Student 1-5
22nd March 2019	3.10 p.m. – 4.10 p.m.	Ticker tape experiment and written test schedule	Document text	Student 6-10
23rd March 2019	2.00 p.m. – 3.00 p.m.	Ticker tape experiment and written test schedule	Document text	Student 11-17
23rd March 2019	3.10 p.m. – 4.10 p.m.	Ticker tape experiment and written test schedule	Document text	Student 18-24

Table 2.2 *Ticker Tape Experiment and Written Test Schedule*

In collecting the data for the study, the primary data will be mainly from the individual's document text, based on their observation and result of the ticker tape obtained in the individual hands-on experiment of the motion of ticker tape. Based on the result obtained, students need to answer the questions in any form of representational format on a piece of paper or verbally. This method can provide good insights into how different participants think and express when dealing with the ticker tape activity. Students' representational format and understanding will be analysed and recorded on a form provided. Besides that, face-to-face individual interview is administered towards students who were not able to write or answer anything based on the questions given. Face-to-face interview is also carried out due to small number of students (Boyce & Neala, 2006) involved to explore their deeper interpretation or extension on their reasoning and conceptual understanding of the motion of ticker tape. The face-to-face interview conversation and verbal answers will be recorded via audio device, and will be transcribed. This study will be conducted based on the conceptual framework provided.

Data analysis

Content analysis will be done to analyse data collected. These data are processed manually using coding method using Microsoft Excel. The number of students of different level learning abilities using various and different representational format as well as their specific understanding on the concept of motion of ticker tape are summarized using bar graph and also diagram. The analysed data is compiled in a diagram of "Model of Form Four Student's Representational Format". The data gathered from the data collection is arranged and summarized according to categories related to the specific objectives; to determine students' representational format in learning the motion of ticker tape, to determine students' understanding on the motion of ticker tape, and to construct a model of students'

representational format of the motion of ticker tape. The information provided by the participants then analysed and interpreted in accordance with the objectives of the study.

CHAPTER THREE

RESULT

The overall purpose of this study was to determine students' representational format of the motion of ticker tape as well their understanding based on level of learning abilities. This study which involved half of the total science stream students from two classes basically gives impact to both students and teachers. We analyse their answers for each question, which was written or drawn on a piece of paper or verbally in order to determine the type of representational format that they use to represent their answer or understanding. Besides that, their specific answer for each questions which show their understanding is also analysed. Correct answer description and explanation shows that students have scientific understanding, while false or incomplete description answer and explanation shows that students have alternative understanding.

3.1 Data Preparation

This step is important for data analysis. After the experiment and written test have been administered, transcription of data was done then data analysis took place (Sutton & Austin, 2015). The session was audio-recorded if the participants chose to answer the question verbally. Thus, the recordings were transcribed verbatim before data analysis can begin. The document text also transcribed.

3.2 Category of Data

The data was arranged under specific objectives that were stated in Chapter 1. It was arranged from the tabulation of responses among students of different learning abilities.

3.3 Content Analysis

After collection of data, it was transferred to excel table, it is time for coding part (Sutton & Austin, 2015). Then, the data was analysed and extracted into simpler information. The information found was supported by previous findings. These analysed data will be arranged in inter-coder analysis.

3.4 Demographic of the Informants

Informant	Gender	Age	Race	School Level	School	Physics' result (March)
S1	F	16	Malay	Secondary	Urban	72
S2	F	16	Iban	Secondary	Urban	68
S3	F	16	Chinese	Secondary	Urban	75
S4	F	16	Bidayuh	Secondary	Urban	68
S5	F	16	Chinese	Secondary	Urban	56
S6	F	16	Malay	Secondary	Urban	58
S7	F	16	Iban	Secondary	Urban	49
S8	F	16	Kenyah	Secondary	Urban	43
S9.	F	16	Iban	Secondary	Urban	42

S10	F	16	Malay	Secondary	Urban	50
S11	F	16	Bidayuh	Secondary	Urban	49
S12	F	16	Chinese	Secondary	Urban	42
S13	F	16	Malay	Secondary	Urban	32
S14	F	16	Malay	Secondary	Urban	36
S15	F	16	Malay	Secondary	Urban	31
S16	F	16	Malay	Secondary	Urban	35
S17	F	16	Malay	Secondary	Urban	28
S18	F	16	Malay	Secondary	Urban	39
S19	F	16	Malay	Secondary	Urban	21
S20	F	16	Malay	Secondary	Urban	25
S21	F	16	Iban	Secondary	Urban	38
S22	F	16	Malay	Secondary	Urban	36
S23	F	16	Iban	Secondary	Urban	39
S24	F	16	Malay	Secondary	Urban	30

Table 3 *Table of informants' demographic (students)*

3.4.1 Informant S1

The first informant in this research is a female student aged 16 years old. She is a Malay student and scored 72 marks in Physics.

3.4.2 Informant S2

The second informant in this research is a female student aged 16 years old. She is an Iban student and scored 68 marks in Physics.

3.4.3 Informant S3

The third informant in this research is a female student aged 16 years old. She is a Chinese student and scored 75 marks in Physics.

3.4.4 Informant S4

The fourth informant in this research is a female student aged 16 years old. She is a Bidayuh student and scored 68 marks in Physics.

3.4.5 Informant S5

The fifth informant in this research is a female student aged 16 years old. She is a Chinese student and scored 56 marks in Physics.

3.4.6 Informant S6

The sixth informant in this research is a female student aged 16 years old. She is a Malay student and scored 58 marks in Physics.

3.4.7 Informant S7

The seventh informant in this research is a female student aged 16 years old. She is an Iban student and scored 49 marks in Physics.

3.4.8 Informant S8

The eighth informant in this research is a female student aged 16 years old. She is a Kenyah student and scored 43 marks in Physics.

3.4.9 Informant S9

The ninth informant in this research is a female student aged 16 years old. She is an Iban student and scored 42 marks in Physics.

3.4.10 Informant S10

The tenth informant in this research is a female student aged 16 years old. She is a Malay student and scored 50 marks in Physics.

3.4.11 Informant S11

The eleventh informant in this research is a female student aged 16 years old. She is a Bidayuh student and scored 49 marks in Physics.

3.4.12 Informant S12

The twelfth informant in this research is a female student aged 16 years old. She is a Chinese student and scored 42 marks in Physics.

3.4.13 Informant S13

The thirteenth informant in this research is a female student aged 16 years old. She is a Malay student and scored 32 marks in Physics.

3.4.14 Informant S14

The fourteenth informant in this research is a female student aged 16 years old. She is a Malay student and scored 36 marks in Physics.

3.4.15 Informant S15

The fifteenth informant in this research is a female student aged 16 years old. She is a Malay student and scored 31 marks in Physics.

3.4.16 Informant S16

The sixteenth informant in this research is a female student aged 16 years old. She is a Malay student and scored 35 marks in Physics.

3.4.17 Informant S17

The seventeenth informant in this research is a female student aged 16 years old. She is a Malay student and scored 28 marks in Physics.

3.4.18 Informant S18

The eighteenth informant in this research is a female student aged 16 years old. She is a Malay student and scored 39 marks in Physics.

3.4.19 Informant S19

The nineteenth informant in this research is a female student aged 16 years old. She is a Malay student and scored 21 marks in Physics.

3.4.20 Informant S20

The twentieth informant in this research is a female student aged 16 years old. She is an Iban student and scored 25 marks in Physics.

3.4.21 Informant S21

The twenty first informant in this research is a female student aged 16 years old. She is a Malay student and scored 38 marks in Physics.

3.4.22 Informant S22

The twenty second informant in this research is a female student aged 16 years old. She is an Iban student and scored 36 marks in Physics.

3.4.23 Informant S23

The twenty third informant in this research is a female student aged 16 years old. She is a Chinese student and scored 39 marks in Physics.

3.4.24 Informant S24

The twenty fourth informant in this research is a female student aged 16 years old. She is a Malay student and scored 30 marks in Physics.

3.5 Findings of the Research

Specific Objective 1: To determine students' representation of the motion of ticker tape.

Attribute 1: Student's specific representation of the motion of ticker tape based on their level of learning ability.

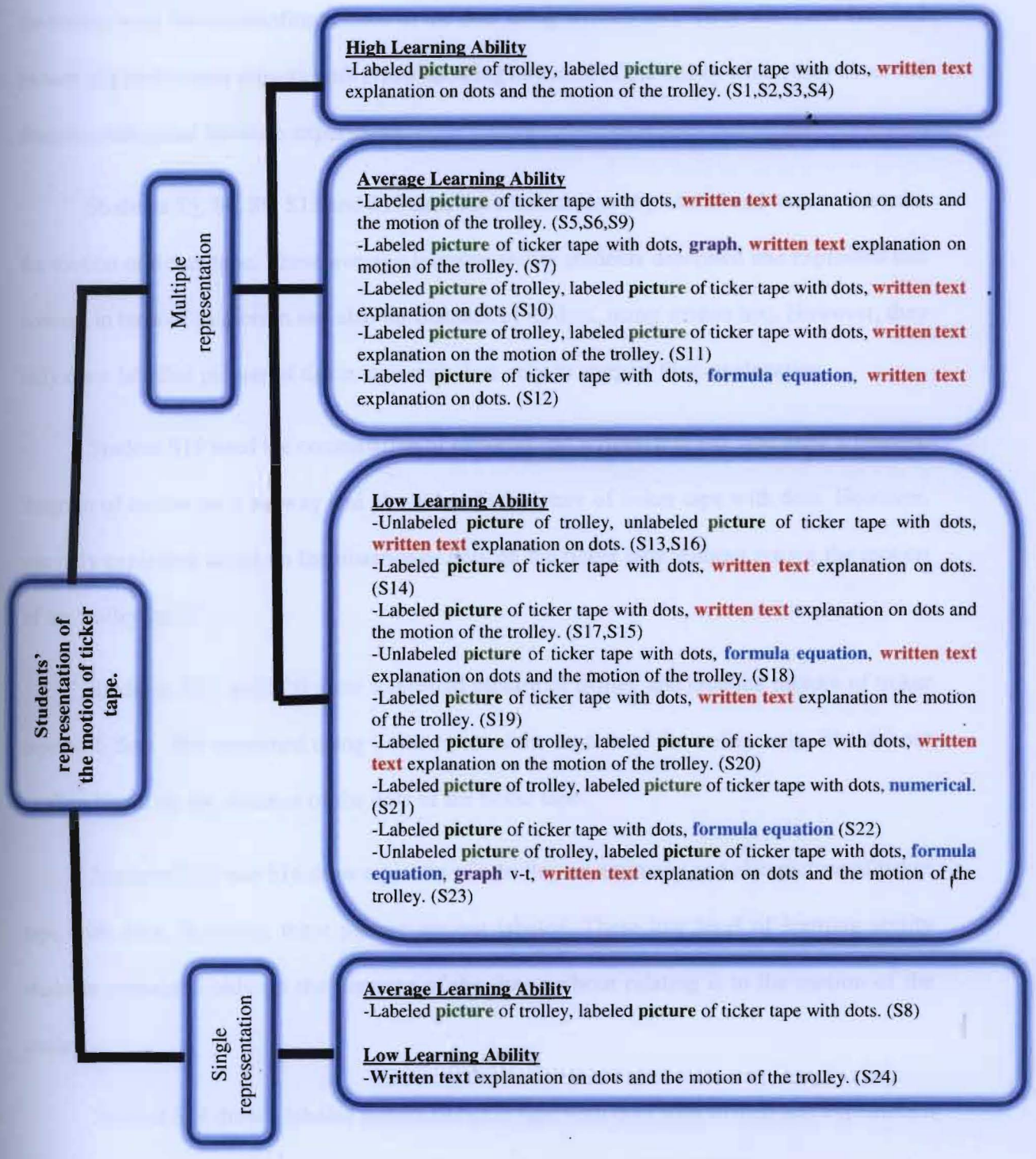


Figure 3.1 *Diagram of Students' Specific Representational Format of the Motion of the Ticker Tape*

Students' Representation of Pictorial and Written Text

Students S1, S2, S3 and S4 used the combination of pictorials and texts to describe the motion of ticker tape. These high level of learning ability students stated clearly the motion of the trolley with the explanation related to the dots using written text. They also drew labelled picture of a trolley on a runway with arrow showing direction of the trolley which they observed from the individual hand-on experiment.

Students S5, S6, S9, S15 and S17 used the combination of pictorial and texts to describe the motion of ticker tape. These average learning ability students described and explained this concept in term of its motion and also the distance of its dots, using written text. However, they only drew labelled picture of ticker tape with dots only to support their explanation.

Student S10 used the combination of pictorial and written text too. She drew a labelled diagram of trolley on a runway and also a labelled picture of ticker tape with dots. However, she only explained based on the distance of dots on the ticker tape without stating the motion of the trolley itself.

Students S11 and S20 drew a labelled picture of trolley and labelled picture of ticker tape with dots. She explained using written text of the motion of the trolley only. She did not explain based on the distance of the dots of the ticker tape.

Students S13 and S16 drew a picture of a trolley on a runway and also picture of ticker tape with dots. However, these picture are not labeled. These low level of learning ability students explained only on the distance of the dots without relating it to the motion of the trolley.

Student S14 drew a labeled picture of ticker tape with dots with written text explanation on the distance of the dots only without relating to the motion of the trolley.

Student S19 drew a labeled picture of ticker tape with dots with written text explanation on the motion of the trolley only without relating it to the distance of the dots.

Students' Representation of Pictorial, Graph and Written Text

Student S7 used the combination of pictorial, graph and written text to describe and explain about this concept. She drew a labelled picture of ticker tape with dots. Then, she explained using written text about the motion of the trolley without relating it to the distance of the dots of the ticker tape. In addition, she also drew a graph of velocity against time where by the relationship between velocity and time is linearly increasing.

Students' Representation of Pictorial, Mathematical and Written Text

Student S12 used the combination of picture of ticker tape with dots, mathematical and also written text to explain about the motion of the ticker tape. She drew a labelled picture of ticker tape with dots with explanation on the distance of the dots only without relating it to the motion of the trolley. Besides that, she stated a formula equation (mathematical) of velocity which is $v = \frac{s}{t}$ with no explanation or numerical substitution on it.

Student 18 drew a picture of ticker tape with dots, however, the picture is not labelled. She described explained using written text of the motion of the trolley by relating it to the distance of the dots. In addition, she wrote a formula equation (mathematical) but no explanation or numerical substitution on the formula.

Students' Representation of Pictorial only

Student S8 used only pictures to describe the motion of ticker tape. She drew a labelled picture of a trolley on a runway and a labelled picture of ticker tape with dots only without any description or explanation on it.

Students' Representation of Pictorial and Mathematics

Both students S21 and S22 used pictorial and mathematical representation to describe the motion of ticker tape. Student S21 drew a labelled picture of trolley on a runway and a labelled picture of ticker tape with dots. She also wrote a number with its unit (mathematical) but no description or explanation about it. Student S22 only drew a labelled picture of ticker tape with dots with a formula equation next to it. Their similarity is, they did not describe or explain about the motion or relate to the ticker tape at all.

Student's Representation of Pictorial, Mathematical, Graphical and Written Text

Student S23 drew a labelled picture of ticker tape with dots. She also drew a picture of a trolley on a runway, however, this picture is not labelled. Besides that, drew a linearly increasing graph of velocity against time and also a formula equation. In addition, she explained using written text of the distance of the dots as well as the motion of the trolley.

Students' Representation of Written Text only

Student S24 only used written text representation to explain the distance of the dots of the ticker tape as well as the motion of the trolley. There were no pictures that support her answer.

Attribute 2: Students Using Multiple or Single Representation in explaining the motion of ticker tape

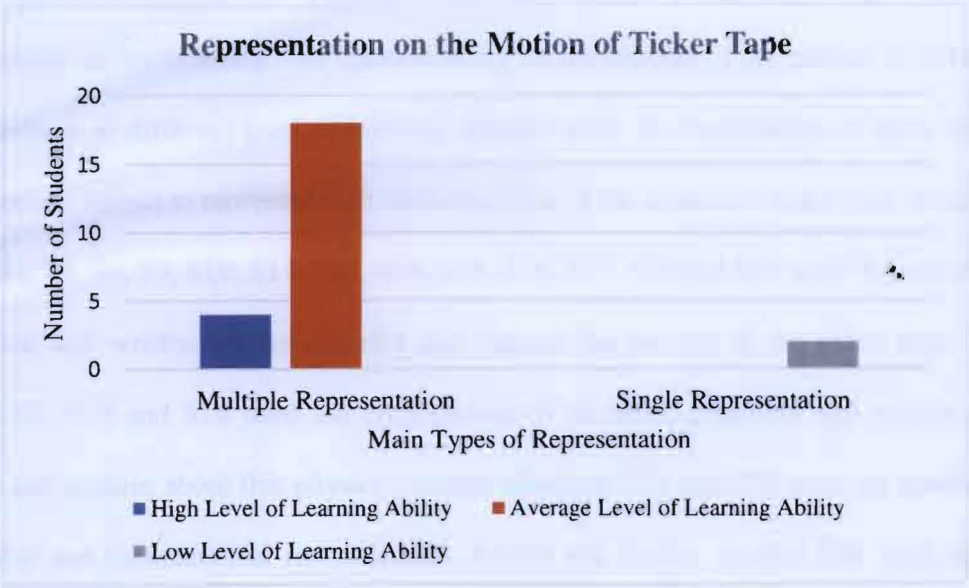


Figure 3.2 *Clustered Column (Graph) of Students' Main Types of Representation*

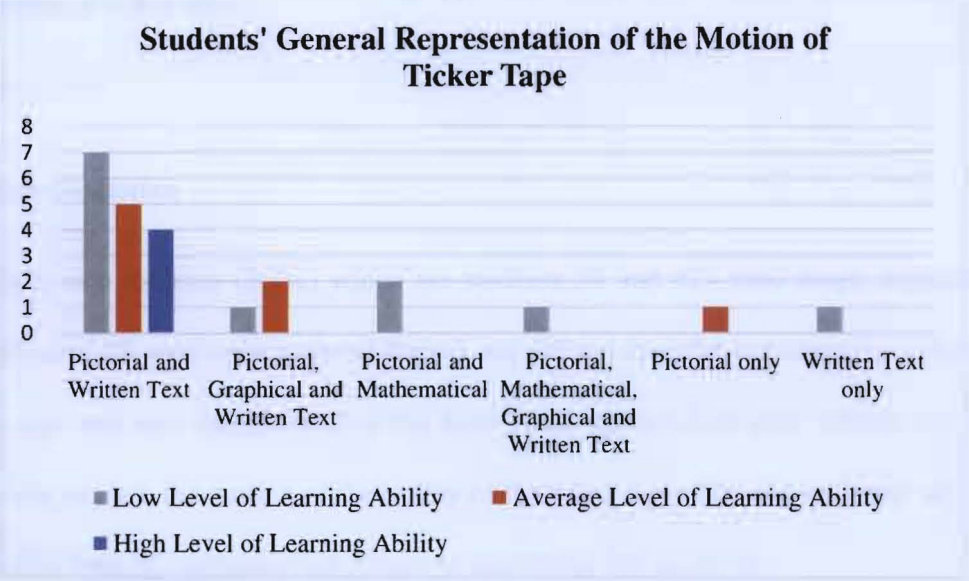


Figure 3.3 *Clustered Column (Graph) of Students' General Types of Representational Format*

Multiple Representation

Majority students (91.7%) which are students S1 until S22 (22 students) used multiple representation in representing their understanding on the concept of the motion of ticker tape. These students of different level of learning abilities used the combination of more than one representation format to represent their understanding of the motion of ticker tape. Student S1, S2, S3, S4, S5, S6, S9, S10, S11, S13, S14, S15, S16, S17, S19 and S20 used the combination of pictorial and written text to describe and explain the motion of the ticker tape. While, students S7, S12 and S18 used the combination of pictorial, graphical and written text to describe and explain about this physics concept. Students S21 and S22 used the combination of pictorial and mathematical representation format and finally, student S24 used the most combination which is pictorial, mathematical, graphical and text to describe and explain about the motion of the ticker tape from the questions given. In summation, students in this all-girls' premier school mostly used multiple representation to represent their understanding or answers of the motion of ticker tape.

Single Representation

Only two students (8.3%) which are students S8 and S24 used single representation format. Student S8 used only pictorial format and did not describe nor explain on the motion of ticker tape and also the distance of the dots which student S24 used written text only to describe and explain the motion of the trolley of the ticker tape. She did not draw any picture nor any other type of representation format in answering this question.

Specific Objective 2: To determine students' understanding of the motion of ticker tape

Attribute 3: Students' understanding of the motion of ticker tape

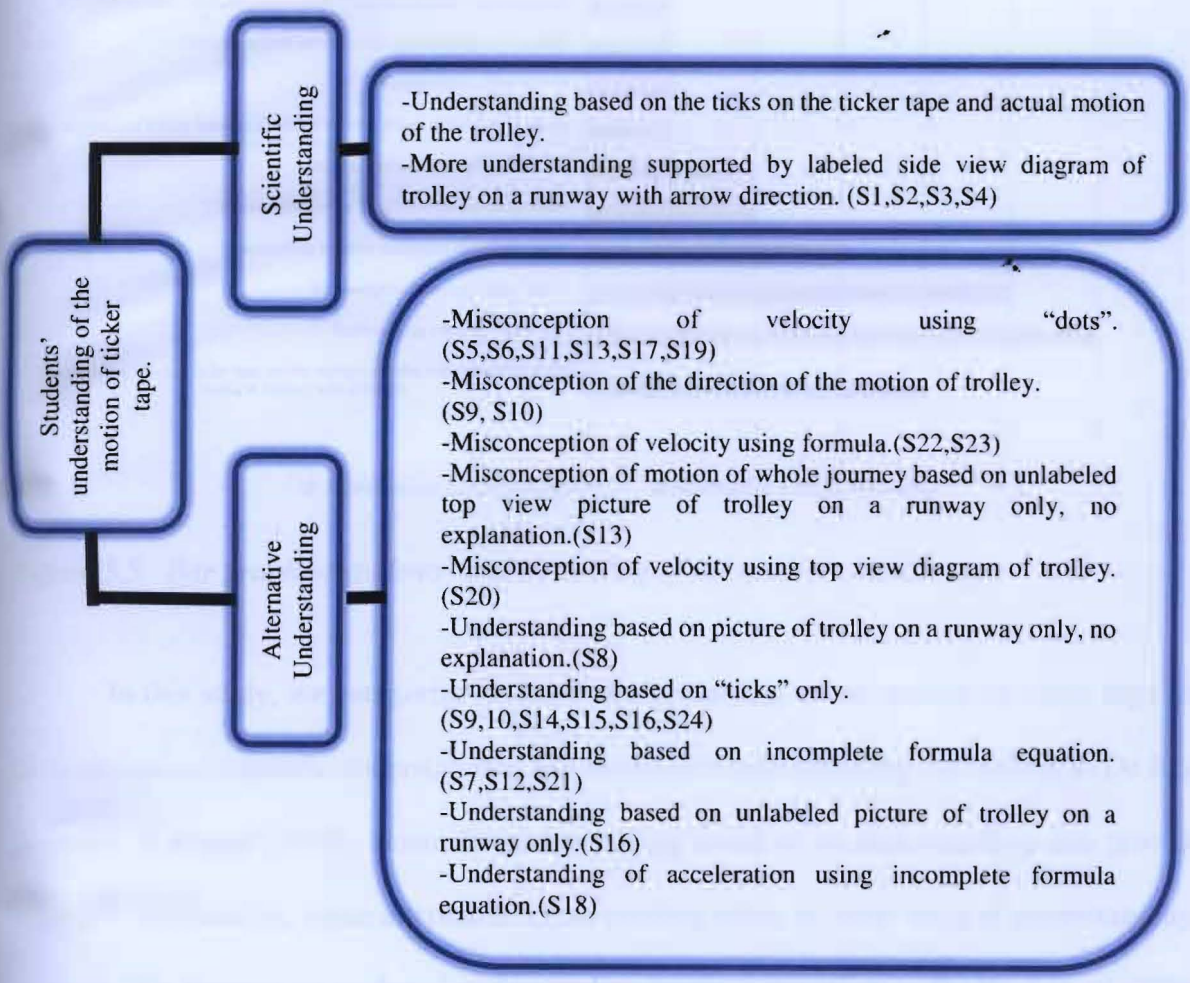


Figure 3.4 *Diagram of students' understanding of the motion of ticker tape*

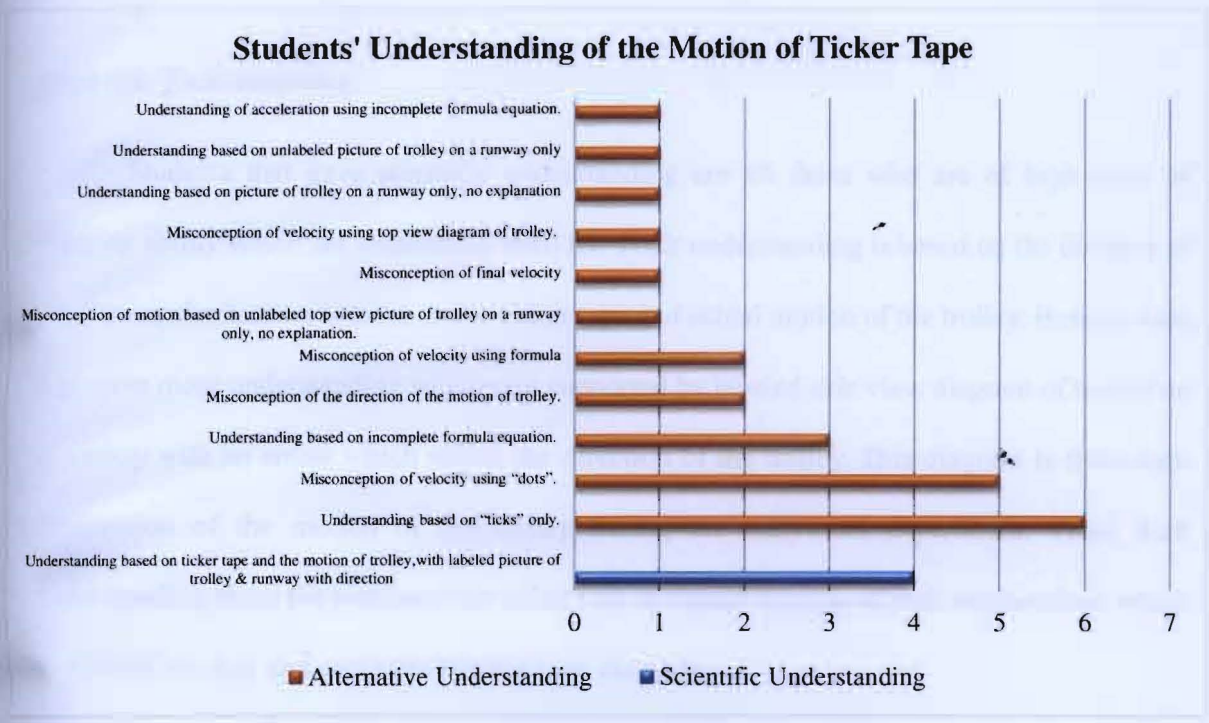


Figure 3.5 *Bar graph of students' understanding of the motion of ticker tape*

In this study, we categorize students' understanding of the motion of ticker tape into two categories; scientific understanding and alternative understanding. According to De Regt, Leonelli, & Eigner (2009), scientific understanding refers to an understanding that provides scientific explanation, while alternative understanding refers to other ways of understanding a concept. We focused on students' understanding because according to De Regt *et. al* (2009), understanding is a central goal of science in the eyes of most scientists and educated laypeople, and according to Lipton (2009), understanding usually comes with explanation.

In this case study which is in the all-girls' premier school in Kuching, most of the students gave alternative understanding compared to scientific understanding. Students of average and low level of learning ability (S5 until S24) tends to show alternative understanding compare to high level of learning ability students (S1 until S4) that showed scientific understanding.

Scientific Understanding

Students that gave scientific understanding are all those who are of high level of learning ability which are students S1 until S4. Their understanding is based on the distance of the dots or also known as ticks on the ticker tape and actual motion of the trolley. Besides that, they gave more understanding which was supported by labeled side view diagram of trolley on a runway with an arrow which shows the direction of the trolley. This diagram is from their observation of the motion of the trolley during the individual experiment. Thus, their understanding about the motion of the ticker tape is clearer because of their explanations which supported by clear and complete labeled both diagrams.

Alternative Understanding (Misconceptions and Incomplete Explanation)

Students that gave alternative understanding are all those who are of average and low level of learning ability (S13 until S24). Students either has misconceptions or gave incomplete explanations of the motion of ticker tape. Findings shows that students gave various types of misconceptions and incomplete explanation.

Misconception of Velocity

Students S5, S6, S11, S13, S17 and S19 has misconceptions of velocity when explaining the distance of the dots. Example of misconception made by student S5 and S6 was stating the first dot as the initial velocity and constant velocity at the same time as shown in Figure 3.6.

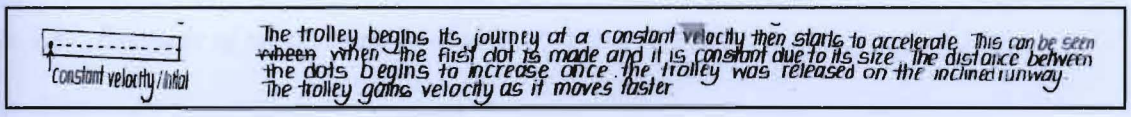


Figure 3.6 *Example of misconception of velocity*

Misconception of the Direction of the Motion of Trolley

Another misconception occurred among students is the direction of the motion of trolley. The arrow direction of the trolley drawn on the ticker tape diagram is incorrect, which oppose the direction of the motion of the trolley, as shown in Figure 3.7. This misconception made by students S9 and S10.

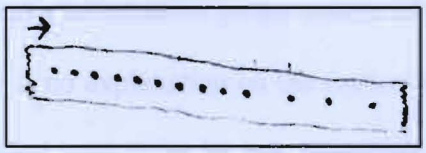


Figure 3.7 *Example of misconception of the direction of the motion of trolley.*

Misconception of Velocity Using Formula

Students S22 and S23 have misconception of the velocity using formula equation. The equation is $v = \frac{s}{t}$, which is $velocity = \frac{displacement}{time}$. For example, when finding the initial velocity, student S22 stated correct formula, however, the substitution of numerical value is inaccurate. Instead of using the length of the first tick to represent displacement, she used the value of time in tick unit in the substitution, which is inaccurate. Her understanding of displacement is in term of time taken in ticks. Figure 3.8 shows an example of misconception of velocity using formula.

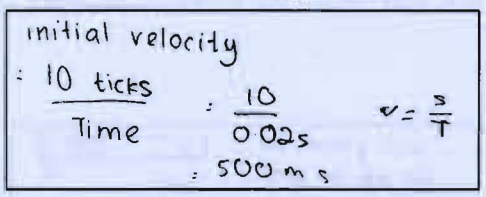


Figure 3.8 *Example of misconception of velocity using formula*

Misconception of the Motion of Whole Journey Based on Unlabeled Top View Picture of Trolley on a Runway

Student S13 made a misconception of the motion of the whole journey of the trolley. And this misconception made due to unlabeled top view picture of trolley on a runway, and according to this student, it was quite confusing. Figure 3.9 show the top view picture which does not tell anything or gives any information on the motion of the whole journey since it was not labeled. In addition, there is no explanation on the motion of the ticker tape and also the distance of the dots of the ticker tape given by her. Her explanation was about its constant direction which is inaccurate, and the neatness of the dots on the ticker tape which is not related.

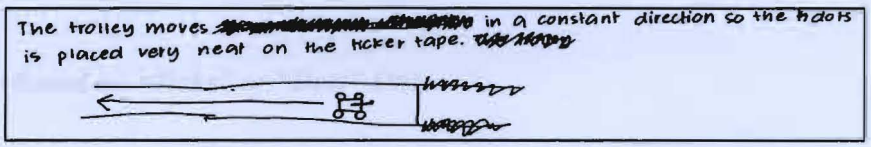


Figure 3.9 *Example of misconception of the whole motion of motion of trolley*

Misconception of Velocity Using Top View Diagram of Trolley

Student S20 made a misconception of velocity too. She drew a top view diagram of a trolley on a runway labeled with initial and final velocity at the same position as shown in Figure 3.10. However, this labeling is inaccurate because final and initial velocity cannot happen at the same time. Her explanation about the trolley that will stop at the end of the initial velocity is also incorrect.

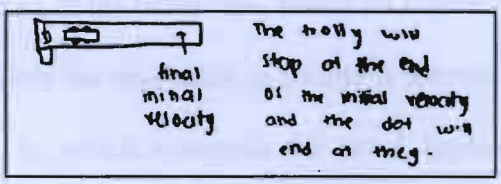


Figure 3.10 *Example of velocity using top view diagram of trolley*

Understanding Based on Picture of Trolley on a Runway Only

Student S8 gave no explanation at all on the motion of the whole journey of a trolley as shows in Figure 3.11, but only a diagram of a trolley on a runway. This picture does not show any explanation of the motion of trolley since it is only labeled with "trolley" and also direction represented by an arrow.

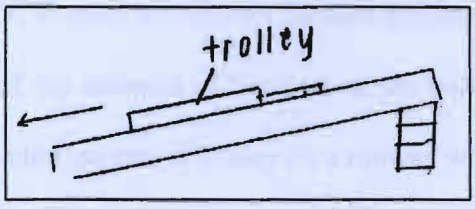


Figure 3.11 *Incomplete explanation based on the picture of trolley on a runway*

Understanding Based on "Ticks" or "Dots" Only

Most students (S9, S10, S14, S15, S16 and S24) explained based on the distance of dots or ticks only without explain on the motion of the trolley. Their explanation is incomplete as shown in Diagram 3.12.

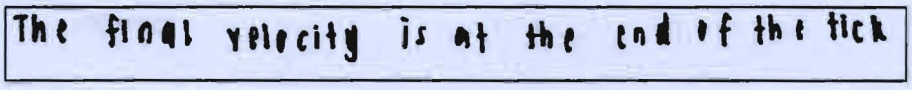


Figure 3.12 *Incomplete explanation based on "ticks" or "dots" only*

Understanding Based on Incomplete Formula Equation

Students S7, S12 and S21 did not give any explanation on the motion of ticker tape as well as the distance of the dots of the ticker tape. Based on Figure 3.13, only a formula which is completely substituted. Only the time taken in second is substituted. She did not substitute the length of the first tick, x_1, which represents the initial displacement of the trolley. This shows incomplete explanation of the motion of ticker tape.

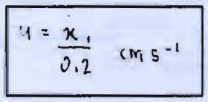


Figure 3.13 *Incomplete explanation based on incomplete formula equation*

Understanding Based on Unlabeled Picture of Trolley on a Runway

Based on Figure 3.14, student S16 did not include explanation on the motion of ticker tape, but only description of the distance of the dots of the ticker tape. This explanation is supported by a side and top view picture of trolley on a runway which is not labeled. It means, the explanation is incomplete.

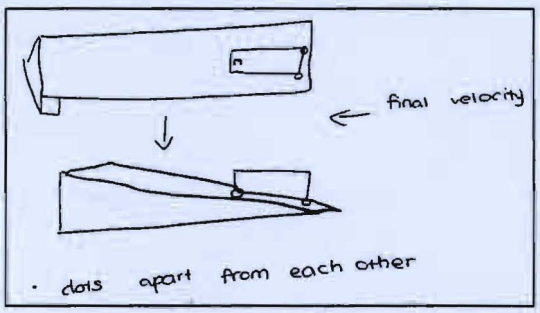


Figure 3.14 *Incomplete explanation based on the unlabeled picture of trolley on a runway*

Understanding of Acceleration Using Incomplete Formula Equation

Student S18 showed her understanding by stating a formula of acceleration. However, there is no explanation from the formula, or even any substitution of value using this formula. Only an explanation of the motion of the trolley based without relating it to the distance between dots, as shown on Figure 3.15.

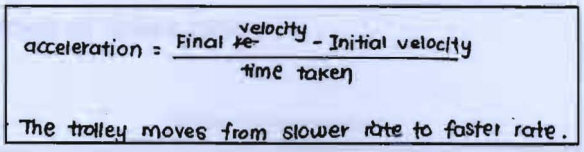
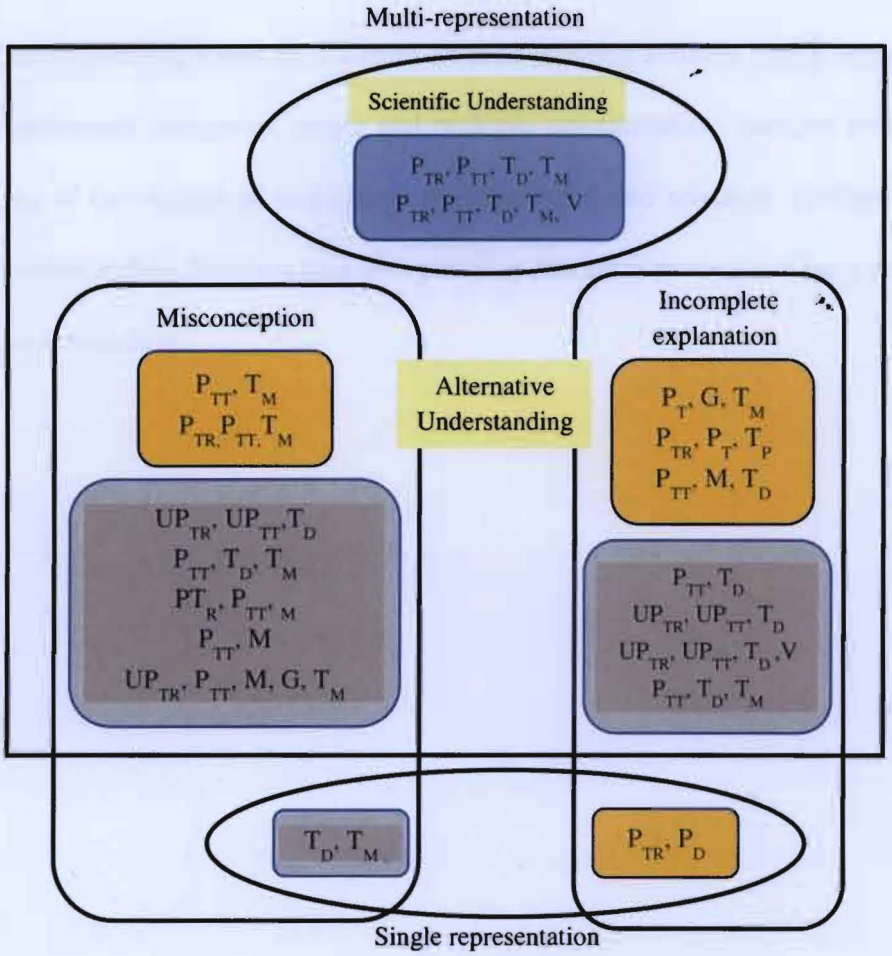


Figure 3.15 *Incomplete explanation using formula equation*

Specific Objective 3: To construct a model of students' representational format of the motion of ticker tape



Indicators:

P_{TR} : Labelled picture of trolley on a runway
UP_{TR} : Unlabelled picture of trolley on a runway
P_{TT} : Labelled picture of ticker tape with dots
UP_{TT} : Unlabelled picture of ticker tape with dots
T_M : Written text with explanation on motion
T_D : Written text with explanation on dots
M : Mathematical representation (formula equation, numbers)
G : Graph
V: Verbal
High Learning Ability
Average Learning Ability
Low Learning Ability

Figure 3.16 *Model of Form Four students' representational format of the motion of ticker tape*

A model of students' representational format is formed based on the findings of specific objectives 1 and 2. This model, as shown in Figure 3.16, shows students' representational format and understanding based on different level of learning abilities which consists of two main representational categories; single and multiple representation. Besides that, students' understanding of the motion of ticker tape is categorized into scientific understanding and alternative understanding. Students misconceptions and incomplete explanation is placed under alternative understanding.

CHAPTER FOUR
DISCUSSION

Students' Representational Format of the Motion of Ticker Tape

There are various types of representational format used by the students in constructing their representation; both informal and formal. Most students preferred to use formal method which is drawing the diagram of trolley on a runway and also diagram of the ticker tape with dots on it, written text describing and explaining the motion of the trolley based on the ticker tape diagram, graph of velocity against time and also mathematical representation which involves equation. However, two students answered verbally the questions given based on their observation of the experiment and also ticker tape. This is parallel to the research done by Kohl & Finkelstein (2005), which claimed that representations can be categorized into formal or informal, abstract or concrete, or text-based versus graphics-based and more. In addition, it is also similar to the study done by Chanijani, Klein, Bukhari, Kuhn & Dengel (2016) in their study which argued that students of different level of understanding tend to use various representations in problem solving. This is because students used either formal or informal or mixed of both methods. They used different types of representations such as pictorial, verbal, written text, graphical, and mathematical.

Students of high level of learning ability group used both pictorial and written text whereby they drew a labelled diagram of trolley and runway with written text description and explanation. These explanations are clear and scientific because they relate it to the motion of the trolley as well as explanation based on the distance of dots on the ticker tape. It is contradicting with the study done by Goolkasian (2000) and Marcus et al. (1996) who claimed that diagram representation is better than textual representation, however, in this case study, both diagrams and written text are important in representing students' understanding of physics

concept. Students of high learning ability used both methods in representing their understanding.

Students of low and average groups that used mathematical representation having difficulties in representing their ideas and understanding. This is similar with the findings found by Kohnle and Passante (2017), whereby they claimed that mathematical representation of physics concepts is challenging for students. They wrote a mathematical equation of physics formula, which is velocity formula. However, they did not explain and relate this formula with the concept of velocity involving ticker tape. This is because they cannot make sense and relate the equations with physics concepts.

High ability students used diagrams of trolley on a runway and ticker tapes with dots to support their explanation. They made scientific explanation on the concept. This is parallel to theory or concept stated by Carney and Levin (2002) which argued that the use of diagrams or pictures is more effective in learning construction. Students can make relations using diagram when writing their description and explanation on the motion of tickertape. Using diagram as supporting representation tool is due to its ability to make relations among explicit elements and make information more concise by highlighting important points and concepts. In addition, this finding also parallel to statement made by Levin (1981) where diagrams can be used as students' assistance in understanding concepts especially challenging problems. It gives benefit to the students in understanding physics concept with the aid of diagram or pictorial representation.

Students of high learning ability, which has better understanding of the motion of ticker tape concept, know how to use various representation compare to other groups. This finding is similar to study done by Sim and Daniel (2014) found that students' overall level of representational competency had higher effect towards students' level of understanding of

concepts. This is because students who has scientific understanding of physics concept produced better representation of the motion of ticker tape.

Similar to studies done by Hubber, Tytler and Haslam (2010), and Prain, Tytler and Peterson (2009) where in this study, low and average group students has low understanding of various representation of the motion of ticker tape concept and processes. Most of them are not able to interpret, coordinate and use it in the representation of the motion via ticker tape in their own generated representation. Similarly, this finding also parallel to study done by Sutopo and Waldrip (2014) which found that representational approach in learning affects students' understanding and reasoning ability. Students that has higher representational ability can solve complex problems related to the motion of ticker tape concept. In addition, this study also similar to study done by Waldrip, Prain and Carolan (2010) whereby they inferred that the use of various representation in student-generated representation can enhance students' conceptual understanding. This is also supported by Kohl, Rosengrant & Finkelstein (2007) which claimed that it is important to know how to use various representations and Malone (2008) who argued that those can solve challenging problems are those with higher representational ability and therefore, the need of learning physics is the ability to use various representations. Thus, the use of student-generated representation is essential to develop better scientific understanding.

Students who consistently represent or support their answers using diagram of trolley and ticker tape for all the questions are those who are of high learning ability group. While, students who inconsistently represent their answer using diagram or other types of representation other than written text alone, are of those of average and low groups. This finding is parallel with study done by Rosegrant, Heuvelen and Etkina (2009) that also found that students who are good in concepts are those who always use representations in learning where consistent practice of the use of various representations is essential among students of high learning ability in physics concept.

Majority students of high, average and low learning abilities used multi-representation in understanding the motion of ticker tape, compared to single representation which was used by one of low learning ability student. This result parallel to the finding found by Ainsworth (2008) whereby in this case study, multiple representation plays major role in students' learning. Representation complement another representation, whereby in this study, diagram, graphical, and mathematical representations complement written text representation. Thus, it can promote deeper understanding of a concept.

Students of high learning ability were able to produce scientific understanding on the motion of ticker tape with the help of written text and diagram which similar with the study done by Waldrip, Prain and Carolan (2010) and Ehrlen (2009). They claimed that student-generated representation promotes understanding in science. However, students of low and average groups did not produce scientific understanding where they made misconceptions and incomplete explanations, eventhough their explanation comes together with diagram, graph and mathematical representation. This is because students' representation was incomplete, for instance, their diagram of trolley on a runway was not labeled as well as their diagram of ticker tape. One of the reason is, most probably, they were not given sufficient information on this concept earlier by teacher, where they need to investigate and relate the concept with the experiment related to ticker tape themselves. In addition, students used various types of representational format to state their understanding and ideas on the motion of ticker tape. This parallel to statement made by Kozma and Russel (2005) whereby similar to their findings, in this case study, students conceptualized their ideas and understanding of the motion of ticker tape using various representations which act as representation tool.

Low and average groups of students produced incomplete explanation and misconceptions on the overall motion of ticker tape. This finding parallel to statement claimed by diSessa (2004) where students will construct good and quality representation provided

enough time and support. Similarly, in this case study, students are not given enough time and support by teacher. Each student is only given 30 minutes to understand, analyze, and construct knowledge and representation on this concept. In addition, students only depend on their initial understanding of this concept and also not given any assistance and guidance by teacher or peers and this supported by study done by Sutopo and Waldrip (2014) that claimed that it is essential to determine students' initial understanding by giving them sufficient input via discussion among students and teacher.

Students constructed representations based on the ticker tape result (representational tool) produced during experiment. This finding is parallel to study done by Prain and Tytler (2012) that argued that students-generated representation promotes students' development in cognitive and reasoning approaches where similarly, in this case study, students of different level of learning ability reasoned their answered based on their supporting representational tool.

In this study, most students used multi-representation which is the combination and pictorial and written text compare to other types of combinations which contradict with findings found by Sutopo (2013). This is because, this study is only on kinematics, whereas the study done by Sutopo (2013), it is also related to kinematics but with dynamic elements.

Students' Understanding on the Motion of Ticker Tape Concept

Average group students, who has better science concept on certain area compare to low group students fail to give their scientific understanding (reason) on the motion of ticker tape. This is similar to study found by Sands and Raine (2014) whereby in this study, students of low and average groups gave incomplete and wrong use of representations. This is due to their lack of knowledge and inconsistent use of various types of representation. Furthermore, in this

study, most students of low and average groups gave alternative understanding which is misconceptions and incomplete explanation on the motion of ticker tape which is similar to study done by Mahmoudy (2008). This is because, they don't have sufficient knowledge on this concept. Besides that, some of them just cannot put things in words eventhough supported with labeled diagram. Some students did not provide enough argument or explanation on the motion of ticker tape. Thus, it is a need to improve their representational skills because it is one of the key element of ultimate sense of scientific literacy (Yore, Pimm, & Tuan, 2007), to make sense of science concept.

Low and average groups of students made misconceptions and incomplete explanation on the motion of ticker tape. This finding is similar with result found by Nguyen et. al (2010) whereby in this study, students of average and low learning abilities that made alternative understanding which refers to misconceptions on concept related to the motion of ticker tape. In addition, some of average and low learning ability students gave incomplete explanation on this concept.

Model of Students' Representation of the Motion of Ticker Tape

Some students of low and average groups used incomplete and unlabeled diagram to support their written text explanation, while the high group students used labeled diagram with complete and scientific explanation on the motion of ticker tape. This result is parallel to study done by Sim and Daniel (2014) whereby in this study, a model of students' representational format is constructed where their finding shows that students of high level of understanding and concepts has high representational competency compared to medium and low groups. The use of multiple representation especially which integrates diagrams is crucial among students of various learning abilities to improve learning and understanding.

Besides that, students represent their understanding either using single or multiple representations. In this case study, most students used more than one type of representations to represent their understanding of the motion of ticker tape. This is similar to the study made by Dufresne *et. al* (2001) in their finding that shows good students who performed well in their examination often the one that can solve wide variety of conceptually difficult problems which needs fluency in different type of representation in order to understand questions and answer questions correctly.

Students of high learning ability groups are able to answer questions because they use complete labeled both diagrams (ticker tape and trolley) to support their answer and this similar to finding found by Goolkasian (2000) where the use of drawn picture can increase students' performance. In this case study, pictorial representation is an effective main representation tool along with written text, and other representation in tackling difficult concepts parallel to previous research done.

A model of representational format is constructed in this study based on the combination of results of students' representation format and understanding of the motion of ticker tape. Most students gave alternative understanding (misconceptions and incomplete explanation) answers which parallel to study done by Onwu and Randall (2006). This is due to students' answers of understanding which is not specific and not scientific, and also explanation did not state the motion of ticker tape, but only the distance of the dots. In other word, students gave insufficient information in their explanation.

Most students used multiple representations in presenting their understanding on the motion of ticker tape which similar to study done by Yuanita and Ibrahim (2015). This finding indicate that lessons, which involve the use of multiple representations, may improve their conceptual understanding of the motion of ticker tape. In this study, most students used multi-representation and there are various types of multi-representation used by students;

a. combination of pictorial and written text representation

b. combination of pictorial, written text and verbal representation

c. combination of pictorial and mathematical representation

d. combination of pictorial, mathematical, graphical and written text representation

e. combination of pictorial, graphical and written text representation

f. combination of pictorial, mathematical representation and written text representation

In addition, only two students used single representation, and the two types of single representation used by students in understanding the motion of ticker tape are:

a. pictorial representation

b. written text representation

Implication of the Study

This research gives implications especially for physics teacher. In 21st learning century, where differentiation of learning is focused, teachers provide different materials, instructions and learning method to tackle students of different learning abilities. Furthermore, teacher provides more exercises of problem solving which require students to draw a diagram and relate it to their explanation. Teachers too stressed on the importance of using labelled diagram in explanation in the classroom. This is crucial so that every student will have the opportunity and chance to learn and understand physics concepts from easy to difficult level as well as HOTS (Higher Order Thinking Skills).

This research also gives implication to the students. Some average group students produced concise answer where they summarized important element in the study in a diagram with explanations. Besides that, students used various representations in their learning notes, not only in physics subject, but also in chemistry and biology. They claimed that it is easier them to understand and memorize using these notes. In addition, some students of low and average group labelled their diagram correctly and carefully. Other than that, some students from low and average groups who previously did not use diagram as supporting tool for their explanation, now already started to use diagrams to support their written text in answering physics questions given in the classroom. Thus, their answers show scientific understanding because of the physics concept and theories that they relate with their explanation with relevant examples.

Suggestions for Future Research

This study could be expanded to include male and female students. This can be done by selecting a number of students from all male schools and also all female schools from few schools in Kuching, to compare students' representational format of the motion of ticker tape based on genders. Besides that, in future, face-to-face interview can be carried out too. This can be done by investigating students' challenges or problems arose when constructing representation should be carried out to determine in-depth explanation or reason to the problems. Other than that, this research should be extended to other topics which is more challenging such as electromagnet and light so that students' difficulty in learning physics can be improved thus, their performance and learning process will be enhanced.

Conclusion

In this study, majority students used multi-representation compared to single representation. We found that students encountered a variety of problems in constructing representation and understanding of the motion of ticker tape. These problem includes unlabelled diagram of trolley and ticker tape, explanation only either based on the motion of ticker tape or motion of trolley only, drawing graph without any explanation or incomplete explanation, incomplete or wrong use of equation with or without explanation, the use of only diagram representation only without any explanation and using only written text representation without any other supporting representation. These problem which mainly occurred among students of low and average level of learning abilities showed alternative understanding which is misconception and incomplete explanation. These results indicate that misconceptions and learning difficulty in physics learning among students especially female is crucial, hence, further action should be taken to overcome this issue. This model of students' representation is parallel to the conceptual understanding in Chapter One. Students used various types of representation to express their understanding of the motion of ticker tape. The model of students' representational format perhaps would help teachers in lesson and activity planning that focused on students' differentiation of learning as well as preparing learning materials especially in learning challenging subject or topics in physics.

REFERENCES

Abdullah Nor. (1998). Kajian mengenai beberapa faktor yang mempengaruhi kecenderungan terhadap Fizik bagi pelajar-pelajar tingkatan empat. Latihan Ilmiah. Universiti Kebangsaan Malaysia, Bangi, Selangor.

Agommuoh, P., & Ifeanacho, A. (2013). Secondary School Students' Assessment of Innovative Teaching Strategies in Enhancing Achievement in Physics and Mathematics. *Journal Of Educational And Social Research, 3*(8), 121.

Ainsworth S. (2008) The Educational Value of Multiple-representations when Learning Complex Scientific Concepts. In: Gilbert J.K., Reiner M., Nakhleh M. (eds) Visualization: Theory and Practice in Science Education. Models and Modeling in Science Education, vol 3. Springer, Dordrecht

Ainsworth, S., & Loizou, A. T. (2003). The effects of self-explaining when learning with text or diagrams. *Cognitive Science*, 27(4), 669–681.

Alias, N., Siraj, S., DeWitt, D., Attaran, M., & Nordin, A. A. (2013). Evaluation on the Usability of Physics Module in a Secondary School in Malaysia: Students' Retrospective. *The Malaysian Online Journal of Educational Technology*, 1(1), 44-53.

Angell, C., Guttersrud, O., Henriksen, E. K. & Isnes, A. (2004). Physics: Frightful, but fun, Pupils' and teachers' views of physics and physics teaching (Electronic version). *Science Education, 88,* 683-706.

Bereiter, C.(2006). "Education and mind in the Knowledge Age". *Archived from the original on 2006-02-25.*

Boyce, C., & Neale, P. (2006). Conducting in-depth interviews: A guide for designing and conducting in-depth interviews for evaluation Input. In *Pathfinder International Tool Series.*

Carney, R. N., & Levin, J. R. (2002). Pictorial illustrations Still improve students' learning from text. *Educational Psychology Review.* https://doi.org/10.1023/A:1013176309260

Chanijani, S. S. M., Klein, P., Bukhari, S. S., Kuhn, J., & Dengel, A. (2016). Entropy based transition analysis of eye movement on physics representational competence. https://doi.org/10.1145/2968219.2968564

Daniel E. G. S. (2004). Penggunaan laman Web pakar: masa depannya dalam pendidikan Sains. dlm. Idris, N., Daniel, E. G. S, & Saat, R. M., *Teknologi dalam pendidikan Sains dan Matematik* (p.93-120). Kuala Lumpur: Universitas Malaya.

De Regt, H., Leonelli, S., & eigner, K. (2009). Focusing on Scientific Understanding. In De Regt H., Leonelli S., & Eigner K. (Eds.), *Scientific Understanding: Philosophical Perspectives* (pp. 1-18) Pittsburgh, Pa. University of Pittsburgh Press. doi:10.2307/j.ctt9qh59s.4

Diedrichsen, J., & Kriegeskorte, N. (2017). Representational models: A common framework for understanding encoding, pattern-component, and representational-similarity analysis. *PLoS Computational Biology*. https://doi.org/10.1371/journal.pcbi.1005508

diSessa, A. (2004). Metarepresentation: Native competence and targets for instruction.*Cognition and Instruction 22*(3) 293-331.

Dufresne, R. J., Gerace, W. J., & Leonard, W. J. (2004). Solving physics problems with multiple representations. University of Massachusetts.

Ehrlen, K. (2009). Drawings as representations of children's conceptions. *International Journal of Science Education*. https://doi.org/10.1080/09500690701630455

Ekici, E. (2016). "Why Do I Slog Through the Physics?" Understanding High School Students' Difficulties in Learning Physics". *Journal of Education and Practice*, 7(7), 95-107.

Fredlund, T., Airey, J., & Linder, C. (2012). Exploring the role of physics representations: An illustrative example from students sharing knowledge about refraction. *European Journal of Physics*, *33*(3), 657–666. https://doi.org/10.1088/0143-0807/33/3/657

Goolkasian, P. (2000). Pictures, words, and sounds: From which format are we best able to reason? *Journal of General Psychology, 127*(4), 439-459.

Gosling, C. (2004). Challenges Facing high school physics students: An annotated synopsis of peer-reviewed literature addressing curriculum relevance and gender. *J. Phys. Tchr. Educ. Online*, 2(2), 1-9.

Gunpinar, Y., & Pape, S. (2018). Teachers' Instructional Practices within Connected Classroom Technology Environments to Support Representational Fluency. *Journal of Computers in Mathematics and Science Teaching*, 37(1), 27-52.

Guttersrud, Ø. (2008). *Mathematical Modelling in Upper Secondary Physics Education.* University of Oslo, Oslo.

Hubber, P., Tytler, R., & Haslam, F. (2010). Teaching and learning about force with a representational focus: Pedagogy and teacher change. *Research in Science Education.* https://doi.org/10.1007/s11165-009-9154-9

Kahle, J. B., & Meece, J. (1994). Research on gender issues in the classroom. In D. L. Gabel (Ed.), *Handbook of Research on Science Teaching and Learning* (pp. 542-557). New York:MacMillan.

Kohl, P. B., & Finkelstein, N. D. (2005). Representational format, student choice, and problem solving in physics. In *AIP Conference Proceedings* (Vol. 790, pp. 121–124). https://doi.org/10.1063/1.2084716

Kohl, P. B., & Finkelstein, N. D. (2006). Effects of Representation of Students Solving Physics Problems: A fine grained characterization. *Physical Review Special Topics - Physics Education Research*, 2(1).

Kohl, P. B., Rosengrant, D. & Finkelstein, N. D. (2007). Strongly and weakly directed approaches to teaching multiple representation use in physics. Physics Review Special Topics - Physics Education Research, 3, 010108.

Kohnle, A., & Passante, G. (2017). Characterizing representational learning: A combined simulation and tutorial on perturbation theory. *Physical Review Physics Education Research*. https://doi.org/10.1103/PhysRevPhysEducRes.13.020131

Kozma, R. & Russell, J. (2005). Students becoming chemists: Developing representational competence. In J. Gilbert (Ed.), Visualization in Science Education (pp. 121–146). London: Kluwer.

Lee, M. N. N. (1989). Science for all: Implications for curriculum efforts. *Journal of Science and Mathematics Education in Southeast Asia*, 12 (1), 16-27.

Leonard, W. G., Gerace, W. J. & Dufresne, R. J. (2002). Analysis-Based Problem Solving: Making Analysis and Reasoning the Focus of Physics Instruction. *Ense anza de las Ciencias [Science Teaching]*, 20(3), 387-400.

Levin, J. R. (1981). On functions of pictures in prose. In Pirozzolo, F. J., and Wittrock, M. C. (eds.), *Neuropsychological and Cognitive Processes in Reading*, Academic Press; New York, pp. 203–228.

Lipton, P. (2009). Understanding without Explanation. In De Regt H., Leonelli S., & Eigner K. (Eds.), Scientific Understanding: Philosophical Perspectives (pp. 43-63), Pittsburgh, Pa: University of Pittsburgh Press. doi:10.2307/j/ctt9qh59s.6

Malone, K. L. (2008). Correlations among knowledge structures, force concept inventory, and problem-solving behaviors. Physics Review Special Topics-Physics Education Research, 4, 020107.

Mahmoudy, M. (2008). *Physics Students' Reasoning Argumentation when Working with Mathematical Modelling Problems (Master Thesis).* University of Oslo, Blindern.

Mok, S. S. (2008). *Ilmu Pendidikan Untuk KPLI (Sek. Rendah:Komponen 1 & 2). Psikologi Pendidikan & Pedagogi.* Kumpulan Budiman Sdn. Bhd., Subang Jaya.

Nguyen, D. H., Gire, E., & Rebello, N. S. (2010). Facilitating students' problem solving across multiple representations in introductory mechanics. In *AIP Conference Proceedings* (Vol. 1289, pp. 45–48). https://doi.org/10.1063/1.3515244

O'Keefe, D. (1997). Secondary physics population in Victoria, analysis of year 12 physics numbers. Paper presented in the 1997 Science Teachers Association of Victoria Physics Teachers Conference, Monash University, Victoria, Australia

Onwu, G. O. M., & Randall, E. (2006). Some aspects of students' understanding of a representational model of the particulate nature of matter in chemistry in three different countries. *Chemistry Education Research and Practice*. https://doi.org/10.1039/B6RP90012G

Prain, V., & Tytler, R. (2012). Learning Through Constructing Representations in Science: A framework of representational construction affordances. *International Journal of Science Education*. https://doi.org/10.1080/09500693.2011.626462

Prain, V., Tytler, R. & Peterson, S. (2009). Multiple representation in learning about evaporation. International Journal of Science Education, 31(6), 787–808.

Rosengrant, D., Heuvelen, A. V. & Etkina, E. (2009). Do student use and understand freebody diagrams? Physics Review Special Topics - Physics Education Research, 5, 010108.

Saleh, S. (2014). Malaysian students' motivation towards Physics learning. *European Journal of Science and Mathematics Education*, 2(4), 223-232.

Saleh, S., & Subramaniam, L. (2018). Effects of Brain-Based Teaching Method on Physics achievement. *Kasetsart Journal of Social Sciences*, 1-5.

Seth, S., Fatin, A. P., & Marlina, A. (2007). *Kemahiran Metakognitif Dalam Kalangan Pelajar Sekolah Menengah di Negeri Johor Dalam Menyelesaikan Masalah Fizik*. Fakulti Pendidikan Universiti Teknologi Malaysia.

Shahar, F.M. (2018, March). SPM 2017 candidates achieve better GPN of 4.90 compared to 2016's results. *News Straits Times*. Retrieved from https://www.nst.com.my/news/nation/2018/03/345348/spm-2017-candidates-achieve-better-gpn-490-compared-2016s-results

Sim, J. H., & Daniel, E. G. S. (2014). Representational competence in chemistry: A comparison between students with different levels of understanding of basic chemical concepts and chemical representations. *Cogent Education*, *1*(1). https://doi.org/10.1080/2331186X.2014.991180

Simpson, R. D., & Oliver, J. S. (1990). A summary of the major influences on attitude toward and achievement in science among adolescent students. Science Education, 74, 1-18.

Sjøberg, S. (2007). PISA and "real life challenges": Mission Impossible? in Hopmann, S.T., Brinek,G. & Retzl, M. (Eds.) (2007) *PISA zufolge PISA – PISA According to PISA,* LIT VERLAG, Berlin.

Snetinova, M., & Koupilova, Z. (2012). Students' Difficulties in Solving Physics Problems. *WDS'12 Proceedings of Contributed Papers*, (III), 93–97.

Sutopo, S. (2013). Improving Students' Representational Skill and Generic Science Skill Using Representational Approach. *Jurnal Ilmu Pendidikan*, 19(1), 7-16 .

Sutopo, & Waldrip, B. (2014). Impact Of A Representational Approach On Students' Reasoning And Conceptual Understanding In Learning Mechanics. *International Journal of Science and Mathematics Education*, 12(4), 741-765.

Sutton, J., & Austin, Z. (2015). Qualitative Research: Data Collection, Analysis, and Management. *The Canadian journal of hospital pharmacy*, *68*(3), 226–231. doi:10.4212/cjhp.v68i3.1456

Utusan Malaysia. (2009). "Dasar 40:60 pelajar sastera sains belum tercapai." http://2pendidikmy.blogspot.com/2009/03/dasar-4060-pelajar-sastera-sains-belum, (accessed March 2009)

Waldrip, B., Prain, V., & Carolan, J. (2010). Using Multi-modal Representations to improve learning in junior secondary science. *Using multi-modal representations to improve learning in junior secondary science*, 40(1), 65-80.

Weinburgh, M. (1995). Gender differences in student attitudes toward science: A meta-analysis of the literature from 1970 to 1991. *Journal of Research in Science Teaching*, 32, 387-398.

Veloo, A., Nor, R., & Khalid, R. (2015). Attitude towards physics and additional mathematics achievement towards physics achievement. *International Education Studies*, *8*(3), 35–43. https://doi.org/10.5539/ies.v8n3p35

Yore, L. D., Pimm, D., & Tuan, H. L. (2007). The literacy component of mathematical and scientific literacy. *International Journal of Science and Mathematics Education.* https://doi.org/10.1007/s10763-007-9089-4Prain, V., & Tytler, R. (2012). Learning Through Constructing Representations in Science: A framework of representational construction affordances. *International Journal of Science Education.* https://doi.org/10.1080/09500693.2011.626462

Yuanita, L., & Ibrahim, M. (2015). Supporting Students in Learning with Multiple Representation to Improve Student Mental Models on Atomic Structure Concepts. *Science Education International.*

APPENDICES

APPENDIX A: INFORMED CONSENT FOR PARTICIPATION

UNIVERSITI MALAYSIA SARAWAK

FACULTY OF COGNITIVE SCIENCES AND HUMAN DEVELOPMENT

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

INFORMED CONSENT FOR PARTICIPATION

This study aims to determine form four students' representational format of the motion of ticker tape implemented in an all-girl's premier schools in Kuching District, Sarawak.

Your participation in this study is voluntary. You are free to withdraw and discontinue your participation at any time. In the event you choose to withdraw from the study, all information you provided will be omitted from the final paper.

Insights gathered from you and the other informants will be used in writing a qualitative research paper and will be presented in the ***KML6066 Research Paper*** course in Masters in Learning Sciences Programme. The paper will also be published in a journal that will be identified by me and my supervisor. Though direct quotes from you maybe used in this paper, your name and other identifying information will be kept anonymous.

It is hoped that the research findings can be used as a reference to the Malaysian Ministry of Education and other relevant parties related to student's representational format in science subjects.

If you have any questions or concerns, please contact the researcher, **Celestea anak Gerunsin** at **0198058165.**

Thank you for your participation.

The Researcher,

Celest.

Celestea anak Gerunsin
Student's ID: 16030497
Faculty of Cognitive Sciences & Human Development
Universiti Malaysia Sarawak

By signing this consent, I _____ agree to the terms of this agreement.

(_____) (_____)

Signature Date

APPENDIX B : APPROVAL FROM THE MINISTRY OF EDUCATION MALAYSIA

KEMENTERIAN PENDIDIKAN MALAYSIA
BAHAGIAN PERANCANGAN DAN PENYELIDIKAN DASAR PENDIDIKAN
ARAS 1-4, BLOK E8
KOMPLEKS KERAJAAN PARCEL E
PUSAT PENTADBIRAN KERAJAAN PERSEKUTUAN
62604 PUTRAJAYA

TEL : 0388846591
FAKS : 0388846579

Ruj. Kami : KPM.600-3/2/3-eras(3460)
Tarikh : 14 Mac 2019

CELESTEA ANAK GERUNSIN
NO. KP : 811210136480

248 TAMAN MALIHAH JAYA 1, JALAN BATU KAWA-MATANG, KUCHING,SARAWAK.
94300 KUCHING
SARAWAK

Tuan,

KELULUSAN BERSYARAT UNTUK MENJALANKAN KAJIAN :
REPRESENTATIONAL SKILLS ON THE LEARNING OF MOTION OF TICKER TAPE

Perkara di atas adalah dirujuk.

2. Sukacita dimaklumkan bahawa permohonan tuan untuk menjalankan kajian seperti di bawah telah diluluskan dengan syarat :

" PENGAJARAN DAN PEMBELAJARAN MURID DI DALAM BILIK DARJAH TIDAK DIBENARKAN. "

3. Kelulusan adalah berdasarkan kepada kertas cadangan penyelidikan dan instrumen kajian yang dikemukakan oleh tuan kepada bahagian ini. Walau bagaimanapun kelulusan ini bergantung kepada kebenaran Jabatan Pendidikan Negeri dan Pengetua / Guru Besar yang berkenaan.

4. Surat kelulusan ini sah digunakan bermula dari **14 Mac 2019** hingga **30 April 2019**

5. Tuan dikehendaki menyerahkan senaskhah laporan akhir kajian dalam bentuk *hardcopy* bersama salinan *softcopy* berformat pdf dalam CD kepada Bahagian ini.Tuan juga diingatkan supaya mendapat kebenaran terlebih dahulu daripada Bahagian ini sekiranya sebahagian atau sepenuhnya dapatan kajian tersebut hendak diterbitkan di mana-mana forum, seminar atau diumumkan kepada media massa.

Sekian untuk makluman dan tindakan tuan selanjutnya. Terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

Ketua Sektor
Sektor Penyelidikan dan Penilaian
b.p. Pengarah
Bahagian Perancangan dan Penyelidikan Dasar Pendidikan
Kementerian Pendidikan Malaysia

salinan kepada:-

JABATAN PENDIDIKAN SARAWAK

* SURAT INI DIJANA OLEH KOMPUTER DAN TIADA TANDATANGAN DIPERLUKAN *

APPENDIX C : QUESTIONS RELATED TO THE MOTION OF THE TICKER TAPE

WORKSHEET

Based on the ticker tape obtained in the experiment,

1. Where is the starting point of the motion of the trolley as shown on the ticker tape? Explain.

2. Describe and explain the direction of the motion of the trolley as shown on the ticker tape.

3. a) Based on the ticker tape, where is the initial velocity of the trolley? Give your reason.

   b) Based on the ticker tape, where is the final velocity of the trolley? Give your reason.

4. Based on the ticker tape, describe and explain the motion of the whole journey of the trolley.

APPENDIX D: TRANCRIPTION AND DOCUMENT TEXT ANALYSIS

NO.	STUDENT	INTERVIEW TRANSCRIPTION DOCUMENT TEXT ANALYSIS
1	S1,S2, S3, S4	1.Used the combination of pictorials and texts to describe the motion of ticker tape, stated clearly the motion of the trolley with the explanation related to the dots using written text, drew labelled picture of a trolley on a runway with arrow showing direction of the trolley which observed from the individual hand-on experiment. 2.Used multiple representation; pictorials and written text 3.Gave scientific understanding which based on the distance of the dots (ticks) on the ticker tape and actual motion of the trolley. They gave more understanding which was supported by labeled side view diagram of trolley on a runway with an arrow which shows the direction of the trolley which was from her observation of the motion of the trolley during the individual experiment. Scientific understanding about the motion of the ticker tape is clearer and concise because of her explanations that supported by clear and complete labeled both diagrams. 4.Student S1 answered verbally: *"The starting point is here because the dots are closer and it moves slower at first. The trolley was here, not moving, when the trolley is not released yet."*
5	S5	1.Used the combination of pictorial and texts to describe the motion of ticker tape, described and explained this concept in term of its motion and also the distance of its dots, using written text and only drew labelled picture of ticker tape with dots only to support explanation. 2.Multiple representation (pictorial and text).

		3.Misconception of velocity when explaining the distance of the dots. Stating the first dot as the initial velocity and constant velocity at the same time.
6	S6	1.Used the combination of pictorial and texts to describe the motion of ticker tape, described and explained this concept in term of its motion and also the distance of its dots, using written text and only drew labelled picture of ticker tape with dots only to support explanation. 2.Multiple representation (pictorial and text). 3. Misconception of velocity when explaining the distance of the dots. Stating the first dot as the initial velocity and constant velocity at the same time.
7	S7	1.Drew a labelled picture of ticker tape with dots. Explanation using written text about the motion of the trolley without relating it to the distance of the dots of the ticker tape. Drew a graph of velocity against time where by the relationship between velocity and time is linearly increasing. 2.Multiple representation (pictorial, graph and written text) 3. No explanation on the motion of ticker tape as well as the distance of the dots of the ticker tape. A correct formula of velocity is written, however, there is no substitution and explanation related to the formula given.
8	S8	1.Drew a labelled picture of a trolley on a runway and a labelled picture of ticker tape with dots only without any description or explanation on it. 2.Single representation (pictorial only). 3. No explanation at all on the motion of the whole journey of a trolley, but only a diagram of a trolley on a runway. This picture does not show any

		explanation of the motion of trolley since it is only labeled with "trolley" and also direction represented by an arrow.
9	S9	1.Used the combination of pictorial and texts to describe the motion of ticker tape, described and explained this concept in term of its motion and also the distance of its dots, using written text and only drew labelled picture of ticker tape with dots only to support explanation. 2.Multiple representation (pictorial and text). 3. Misconception in determining the direction of the motion of trolley. The arrow direction of the trolley drawn on the ticker tape diagram is incorrect, which oppose the direction of the motion of the trolley. 4.Explanation based on the distance of dots or ticks only without explain on the motion of the trolley. Explanation is incomplete.
10	S10	1.Used combination of pictorial and written text, drew a labelled diagram of trolley on a runway and also a labelled picture of ticker tape with dots. Explanation based on the distance of dots on the ticker tape without stating the motion of the trolley itself. 2.Multiple representation (pictorial and text). 3. Misconception in determining the direction of the motion of trolley. The arrow direction of the trolley drawn on the ticker tape diagram is incorrect, which oppose the direction of the motion of the trolley. 4.Explanation based on the distance of dots or ticks only without explain on the motion of the trolley. Explanation is incomplete.
11	S11	1.Drew a labelled picture of trolley and labelled picture of ticker tape with dots. Explained using written text of the motion of the trolley only. Did not explain based on the distance of the dots of the ticker tape.

		2.Multiple representation (pictorial and text). 3. Misconceptions of velocity when explaining the distance of the dots. Not specifically mentioned the velocity. Explanation in term of accuracy of velocity.
12	S12	1.Drew a labelled picture of ticker tape with dots with explanation on the distance of the dots only without relating it to the motion of the trolley. Wrote formula equation (mathematical) of velocity which is $v = \frac{s}{t}$ with no explanation or numerical substitution on it. 2.Multiple representation (pictorial, mathematical and written text) 3. No explanation on the motion of ticker tape as well as the distance of the dots of the ticker tape. Only a formula where the time taken in second is substituted. No substitution on the length of the first tick, x_1, which represents the initial displacement of the trolley. This shows incomplete explanation of the motion of ticker tape.
13	S13	1.Drew unlabeled picture of a trolley on a runway and also picture of ticker tape with dots. Explanation based on the distance of the dots without relating it to the motion of the trolley. 2.Multiple representation (pictorial and text). 3. Misconceptions of velocity when explaining the distance of the dots. Explanation based on its starting point alone. 4.Misconception of the motion of the whole journey of the trolley. And this misconception made due to unlabeled top view picture of trolley on a runway, and according to this student, it was quite confusing. The top view picture which does not tell anything or gives any information on the motion of the whole journey since it was not labeled. There is no explanation on

		the motion of the ticker tape and also the distance of the dots of the ticker tape given by her. The explanation was about its constant direction which is inaccurate, and the neatness of the dots on the ticker tape which is not related.
14	S14	1.Drew a labeled picture of ticker tape with dots with written text explanation on the distance of the dots only without relating to the motion of the trolley. 2.Multiple representation (pictorial and text). 3.Explanation based on the distance of dots or ticks only without explain on the motion of the trolley. Explanation is incomplete.
15	S15	1.Used the combination of pictorial and texts to describe the motion of ticker tape, described and explained this concept in term of its motion and also the distance of its dots, using written text and only drew labelled picture of ticker tape with dots only to support explanation. 2.Multiple representation (pictorial and text). 3.Explanation based on the distance of dots or ticks only without explain on the motion of the trolley. Explanation is incomplete.
16	S16	1.Drew unlabeled picture of a trolley on a runway and also picture of ticker tape with dots. Explanation based on the distance of the dots without relating it to the motion of the trolley. 2.Multiple representation (verbal, pictorial and text). 3.Explanation based on the distance of dots or ticks only without explain on the motion of the trolley. Explanation is incomplete. 4. No explanation on the motion of ticker tape, but only description of the distance of the dots of the ticker tape. This explanation is supported by a

		side and top view picture of trolley on a runway which is not labeled. It means, the explanation is incomplete. 5. Answer of initial velocity: *"It is at here. Because the distance is close, the dots, and it is the first point."*
17	S17	1.Used the combination of pictorial and texts to describe the motion of ticker tape, described and explained this concept in term of its motion and also the distance of its dots, using written text and only drew labelled picture of ticker tape with dots only to support explanation. 2.Multiple representation (pictorial and text). 3. Misconceptions of velocity when explaining the distance of the dots. Explanation based on starting point alone.
18	S18	1.Drew an unlabelled picture of ticker tape with dots. Explanation using written text of the motion of the trolley by relating it to the distance of the dots. Wrote a formula equation (mathematical) but no explanation or numerical substitution on the formula. 2.Multiple representation (pictorial, mathematical and written text). 3. Stating a formula of acceleration. However, there is no explanation from the formula, or even any substitution of value using this formula. Only an explanation of the motion of the trolley based without relating it to the distance between dots.
19	S19	1.Drew a labeled picture of ticker tape with dots with written text explanation on the motion of the trolley only without relating it to the distance of the dots. 2.Multiple representation (pictorial and text).

		3. Misconceptions of velocity when explaining the distance of the dots. Explanation of final velocity based on the last dot alone (when it stops).
20	S20	1.Drew a labelled picture of trolley and labelled picture of ticker tape with dots. Explained using written text of the motion of the trolley only. Did not explain based on the distance of the dots of the ticker tape. 2.Multiple representation (pictorial and text). 3.Misconception of velocity. Drew a top view diagram of a trolley on a runway labeled with initial and final velocity at the same position. Inaccurate labeling because final and initial velocity cannot happen at the same time. Explanation about the trolley that will stop at the end of the initial velocity is also incorrect.
21	S21	1.Drew a labelled picture of trolley on a runway and a labelled picture of ticker tape with dots. Wrote a number with its unit (mathematical) but no description or explanation about it. Their similarity is, they did not describe or explain about the motion or relate to the ticker tape at all. 2.Multiple representation (pictorial and mathematical) 3. No explanation on the motion of ticker tape as well as the distance of the dots of the ticker tape. Only a calculation using incorrect formula. The calculation of velocity is based on the time taken alone.
22	S22	1.Drew labelled picture of ticker tape with dots with a formula equation next to it. 2.Multiple representation (pictorial and mathematical)

		3. Misconception of the velocity using formula equation. The equation is $v = \frac{s}{t}$, which is $velocity = \frac{displacement}{time}$. When finding the initial velocity, a correct formula is written, however, the substitution of numerical value is inaccurate. Instead of using the length of the first tick to represent displacement, she used the value of time in tick unit in the substitution, which is inaccurate. Her understanding of displacement is in term of time taken in ticks.
23	S23	1.Drew a labelled picture of ticker tape with dots, unlabelled picture of a trolley on a runway. Drew a linearly increasing graph of velocity against time and also a formula equation. Explanation using written text of the distance of the dots as well as the motion of the trolley. 2.Multiple representation (pictorial, mathematical, graphical and written text) 3. Misconception of the velocity using formula equation. Stating incorrect formula of initial velocity. Used the formula of time taken for an acceleration for initial velocity.
24	S24	1.Explanation of the distance of the dots of the ticker tape as well as the motion of the trolley using written text. There was no diagram. 2.Single representation (written text). 4.Explanation based on the distance of dots or ticks only without explain on the motion of the trolley. Explanation is incomplete.

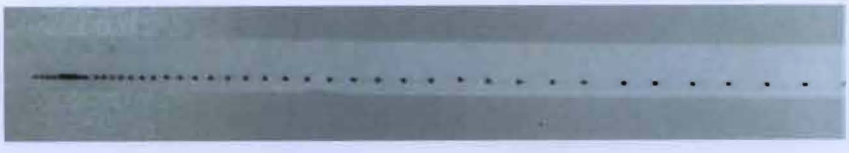
APPENDIX E: PICTURES OF STUDENT WHEN CARRIED OUT THE TICKER TAPE EXPERIMENT



Student set up the apparatus and materials



Student observed the motion of the trolley and the ticker tape

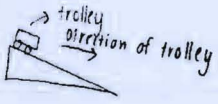


Result of the motion of the trolley on the ticker tape (based on dots)

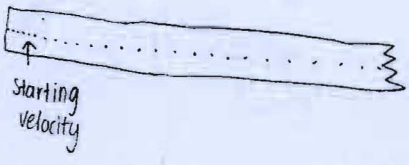
APPENDIX F: STUDENTS' ANSWER SCRIPT (DOCUMENT TEXT)

STUDENT 1

(2) Inference : The direction of the trolley is the direction of motion



(3)



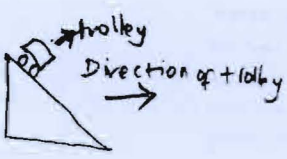
At first the gaps between the dots are constant, then the gaps become bigger. The first and second dots that show bigger gap, that is the starting velocity.

(4)



The dot stop there. Therefore, it is the final velocity.

(5) Distance of dots (ticks) increases -
The trolley moves down the inclined plane. At first, the trolley moves slowly. Then, it accelerates.



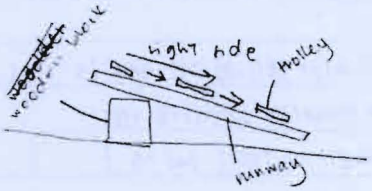


STUDENT 2

1) The starting point of my ticker tape is shown [illegible] the start dot.

2) → direction of motion

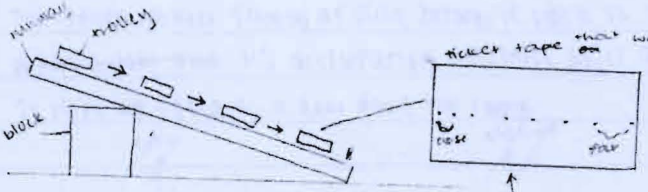
It is because the inclined runway towards the right and thus the trolley will go towards the same way.



3) The place which shows initial velocity is found at the 1st strip of the ticker tape. It is because this is where the [illegible] movement of the trolley starts

(ii) The place which shows final velocity in my ticker tape is at the 7th strip because it is where the velocity increases and stops.

4)



the dots that were once close to each other were slowly going further away because as the trolley that moved down the runway has a acceleration that changed the velocity of the trolley

5) Based on your tape chosen, describe and explain

STUDENT 3

1



starting point

The dots are darkest at the start of the ticker tape

2

direction of motion of trolley



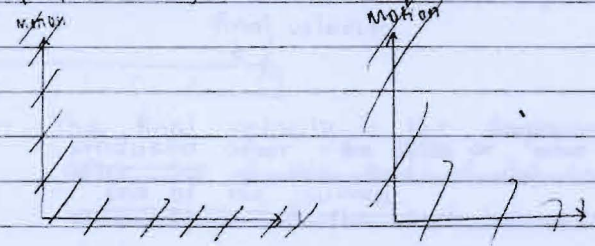
The trolley moves faster as it goes down the ramp

3 a) ~~The~~ As Initial velocity of the trolley is at the first 10 ticks, the distance between each dots are closer. (at the start of the ramp .)

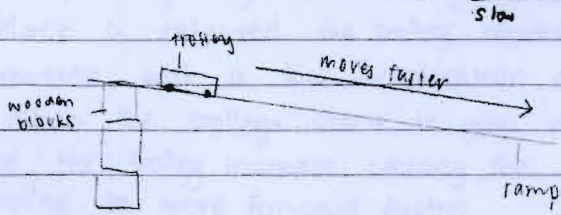
b) Final velocity of the trolley is at the last 10 ticks of the ticker tape when the trolley reaches the end of the ramp and is stopped. The distance between each dots are further

4 The trolley moves slowly at first before it starts to speed down the ~~velocity~~ ramp ~~it has a low acce~~ it's acceleration increases as it goes down the ramp

It picks up speed as it goes down the ramp.

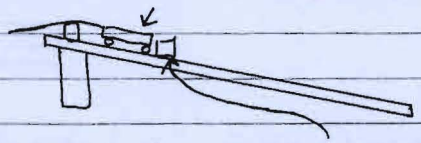


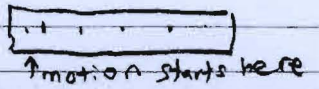




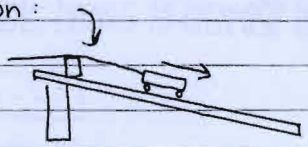
STUDENT 4

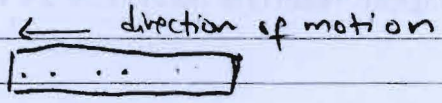
1. The motion starts at the beginning ~~of the~~





This is because when the block is released, the trolley moves down the inclined ~~ramp~~ pathway, ~~create~~ creating a forward linear motion:

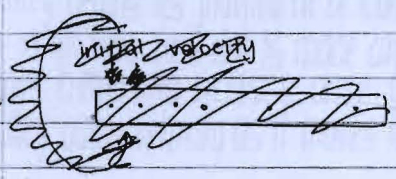




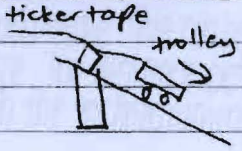
2. Direction of motion: moves forward linearly with acceleration

~~Explain the motion: Trolley moves forward in a linear motion~~

3.







a) The trolley's ~~gains~~ velocity at the starting point. ~~The ticker timer shows the velocity at~~ Initial velocity is the velocity gain in the beginning of the journey

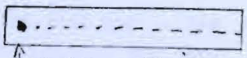
4.



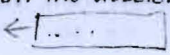
b) Reason: The final velocity is the ~~displacement~~ velocity ~~produced~~ produced after ~~the it is~~ or ~~the~~ or towards the ~~after the at the end of the activity. The final~~ end of the journey ~~velocity is at the end because it gain~~

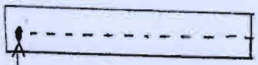
4. In the beginning, the trolley is stationary, when the block is released, the trolley moves forward in a linear motion with a low acceleration and low velocity. When the trolleys starts to gain velocity, the acceleration of the trolley increase causing the motion of the trolley to move forward faster.

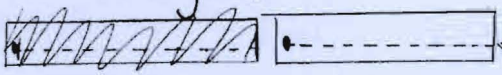
STUDENT 5

1) 

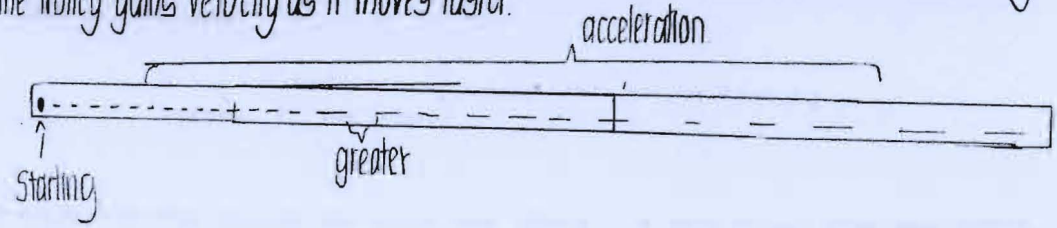
2) The direction of the trolley is shown as above because the ~~ticker tape~~ starting point of the ticker tape shows the constant velocity before ~~its~~ it accelerates. The distance or ~~ticks~~ between the dots begins to increase to show the acceleration and ~~motion~~ motion



3) 

4) 

5) The trolley begins its journey at a constant velocity then starts to accelerate. This can be seen ~~wheen~~ when the first dot is made and it is constant due to its size. The distance between the dots begins to increase once the trolley was released on the inclined runway. The trolley gains velocity as it moves faster.



STUDENT 6

①



56

- The first dot is the starting point. It's because we count the space between the dots but we know the first dot is the starting point.

②

It is because the starting dots is closed to each other or slow. Then, it starts to get faster. That's mean the direction of the trolley is to the right

②



The initial velocity is the starting point or dots while the final velocity is the last dots where the trolley already stopped

③

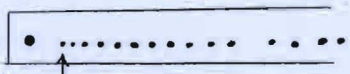


This is the final velocity where the trolley already stopped or not moved

-On my ticker tape, at first the points are closed to each other than far apart to each other. That is mean the trolley moved slow than it is moved faster

STUDENT 7

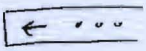
① a)



(speak)

The starting point is here because the first point is where the ticker times need to be stabilise.

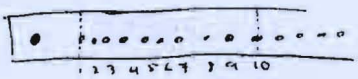
b)



c) it follows the trolley from high place to low place. (draw)

(speak)

② initial velocity



- initial every 10 ticker point x length of the ticker tape of 10 ticker tape.

final velocity



- the final calculation for all point until the end of the point

③ The whole journey of the trolley.

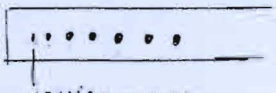


= explanation

the velocity = $\frac{\text{displacement}}{\text{time taken}}$, is increasing.

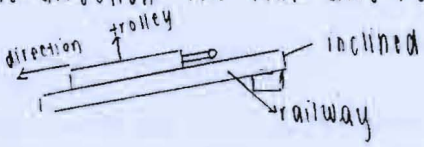
STUDENT 8

1. Identify the starting point



2. Draw the motion of the trolley

3. Why is the direction like that? Give reasons.

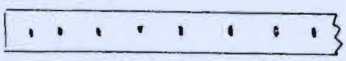


4 Based on the ticker tape, where is the initial velocity?



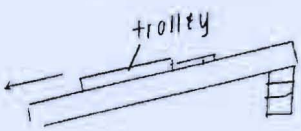
Describe and explain.

5. Where is the final velocity?



describe and explain.

6. Based on the ~~ticker tape~~ experiment, describe, and explain the whole journey.



STUDENT 9

Dayang Nur Atiqah 4Duncomb



2. So that the ticks will produce on the ticker tape. The direction of the motion also makes the ticks increase on the ticker tape.

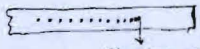


3. Final velocity of the ticker tape the distance of the last tick on the ticker tape

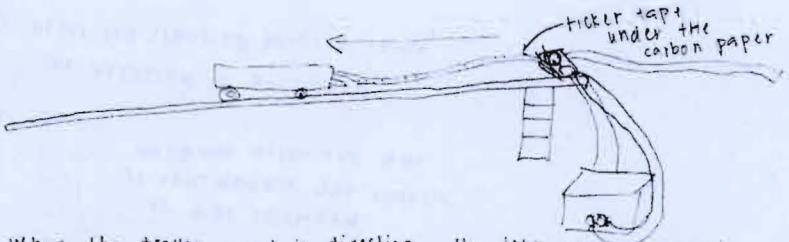
4. When the trolley was pushed down the runaway, the distance between the ticks remain constant after few ticks, the distance of the ticks became different because the velocity is getting higher.

STUDENT 10

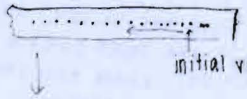
S10

1. 

2.  direction of trolley moved

3. 

When the trolley moved in direction , the dots will produced on the ticker tape across the carbon paper on the ticker-timer.

4. 

5. On the 4th dots

6. 

final velocity

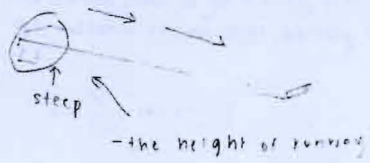
↓

7. On the last dots of the ticker tape

8.  The trolley moved downward on the runway and moved smoothly. The distance between the 2 dots (1 tick) increase on the ticker tape.

STUDENT 11

2. because the runway is incline which makes it move down



S11

3. after the starting point because the velocity is accurate

3. ← because after the dot is the double dot which is not counted.

4 The starting point has an accurate velocity but by the end, it becomes inaccurate which makes it to have double dots. The lines of the tick is quite straight which means that the position of the ticker tape does not move. The velocity of the trolley changes.

STUDENT 12

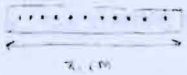
① The starting point is at the very first strips with 10 ticks because it is the point where the ticker timer starts and the distance of each ticks are very close.

$$v = \frac{x_1}{0.2} \text{ cm s}^{-1}$$

② The direction of arrow is to the right because the trolley moves forward.

Initial velocity:

② At the very first strips of 10 ticks.



x_1 cm

$$v = \frac{x_1}{0.2} \text{ cm s}^{-1}$$

Final velocity.

At the 4th or 5th strip of 10 ticks

$$v = \frac{\text{length}}{0.2} \text{ cm s}^{-1}$$

STUDENT 13

1. .....

S13

2 ~~2~~

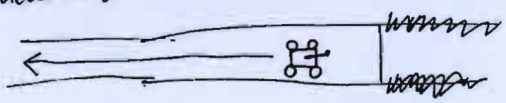
~~3 The trolley dots on the ticker tape is~~

3. The trolley moves faster to the left. The dots on the ticker tape is ~~getting closer~~ is have
2. ~~digital~~ ticks because the trolley moves faster.

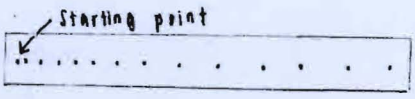
~~4.~~ 3. The starting point of the dots. The ticker timer vibrates on the first point.

4. The last point of the dots. ~~The last one~~ The final vibration is on the last point

5. The trolley moves ~~[redacted]~~ in a constant direction so the ~~the~~ dots is placed very neat on the ticker tape. ~~The trolley~~

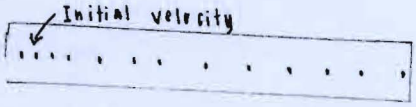


STUDENT 14

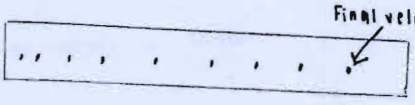
1) 

: The starting point is at the first tick on the ticker tape because the starting point is based on the movement of the trolley from its first move until the end. S14

The error moves at the right direction as the trolley goes forward in a straight line.

2) 

: The initial velocity is at the first tick



: The final velocity is at the end of the tick

3) The acceleration of the velocity of the ticker tape increases consistently as the trolley moves in its direction (straight line).

STUDENT 15

S15

Initial velocity
↓
. . . . . .

- that is where the distance starts to become constant

long velocity
↓
. .

- the distance is constant

The whole journey of the trolley
- The trolley starts slow and gradually becomes faster

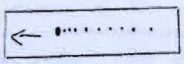
. . . . . .

↑ slow, very close to each other

↑ starts to become faster (become further apart from each other)

STUDENT 16

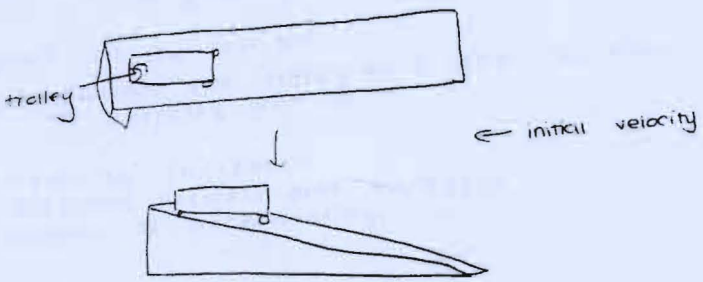
SH

1) 

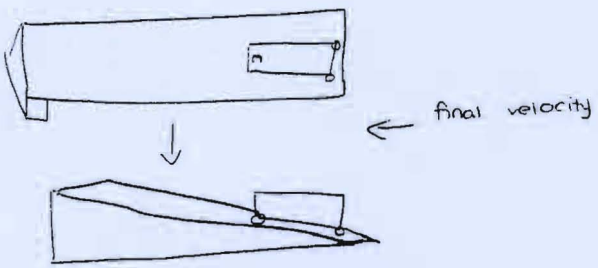
a) * on the ticker tape *

b) the trolley ~~is~~ is moving to the left and the dots is to the right.

2)



· ~~el~~ dots ~~are~~ close to each other



· dots apart from each other

STUDENT 17

1) starting point

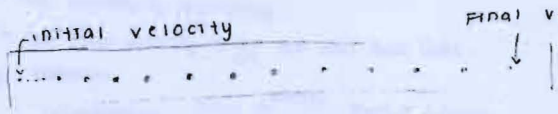


motion of ~~trolley~~

Reason - Because the ~~point is placed at the this ticker~~ ticker tape is placed at the ticker time, ~~and~~ when the trolley move forward the starting point was formed.

~~Reason~~ Reason - Because ~~the~~ when the trolley being pushed towards the motion of the trolley goes opposite direction

2) initial velocity Final velocity



a) describe: At the starting point

Explanation: The initial velocity is the dot at the starting point

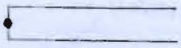
b) describe: At the last dot

Explanation: when the trolley were stop the final velocity was form

3) - The velocity increases
- The distance between dots increases
- The object is accelerating.

STUDENT 18

(S18)

1. (a) 

The starter point is on the first dot. It is the starter point because it is first mark before the trolley starts to move.

2. (b) 

The direction of the arrow goes to the right side because it moves in a linear motion.

(a) - The initial velocity for the distance is from the first two dots.
- The velocity is increasing.

(b) - The final velocity is ~~on~~ on the last two dots.

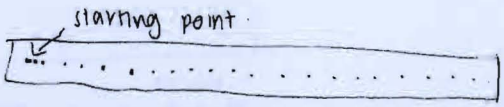
(c) ~~velocity.~~

$$\text{acceleration} = \frac{\text{Final velocity} - \text{Initial velocity}}{\text{time taken}}$$

- The trolley moves from slower rate to faster rate.

STUDENT 19

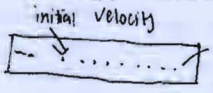
SP9

1. 

The thicker time is started before the trolley move so its a little bit dark in colour and looks double. as soon it moves the tick at the end, the gap a little further from each tick because the trolley moves faster.

2. Because as the trolley move, the tick that moves is opposite from the direction the trolley move.

2. the initial velocity start when trolley is start moving and the final velocity when the trolley is stop moving.



3. the trolley is move at the plank when it start to move is JU the trolley just move slowly when the trolley is at the end point it move faster.

4.

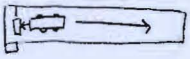
STUDENT 20



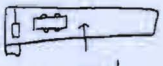
Because it is the first dot

the starting point

Because it will move doward



2)



initial velocity

The trolly will move faster at the initial velocity.



final initial velocity

The trolly will stop at the end of the initial velocity and the dot will end at they.

- If we push the trolly it will move faster going down.
- The faster the trolly the faster the time taken.

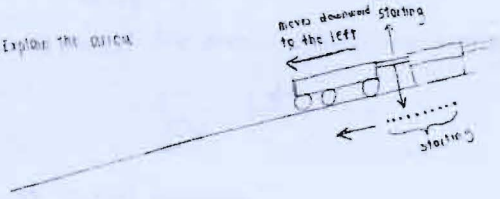
STUDENT 21

1) .....

Starting point

because the dots are near to each other → the ticker moves slower at the starting point

)Explain the action



S21

3) .....

initial velocity

10 x 0.02
= 0.2 second

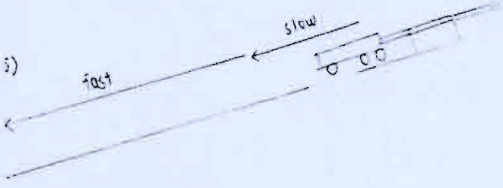
4) .....

Final velocity

Final velocity = 60 x 0.02 : 1.2 second

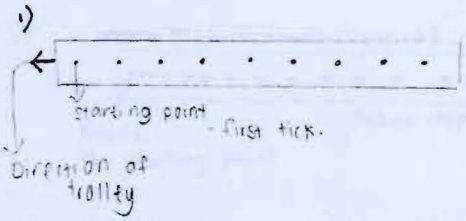
Example 0.02 → 1 tick

5)



STUDENT 22

1)



- because the arrow shows the trolley's direction & opposite site



2) initial velocity

$\frac{10 \text{ ticks}}{\text{Time}}$ $\frac{10}{0.02s}$ $v = \frac{s}{t}$

500 m s

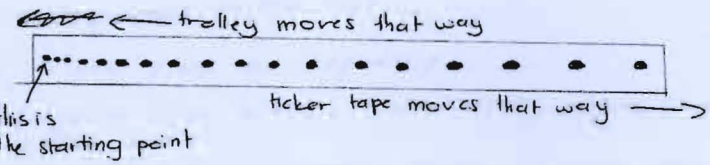
3)

4) The time taken = 0.02s

st

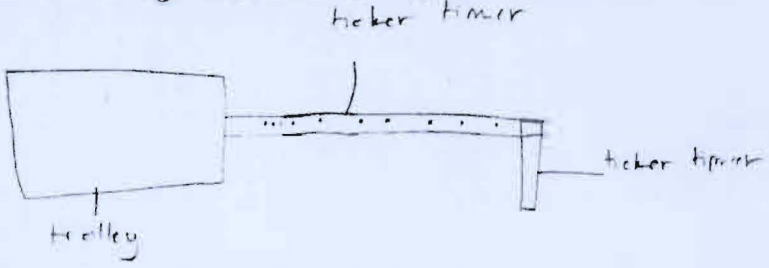
STUDENT 23

1) ~~trolley~~ ← trolley moves that way



This is because the dots ~~only started~~ ~~to~~ are close to each other. and gradually becomes further than each other.

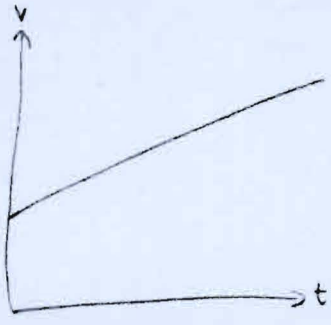
2) 1) This is because the trolley was only starting to move therefore the dots are close to each other. ~~Once~~ The dots gradually become further than each other because the trolley was moving down the ramp at a fast rate.



2) The initial velocity is the number of strips, minus one and divided ~~into~~ with 0.2. This is because 0.2 is the ~~rate of~~ time taken between two dots. (tick)

3) the tick in the last strip ~~as~~ divided with 0.2.

4) The trolley moves down the ramp at a high velocity. ~~This made~~



~~The velocity increases at~~

STUDENT 24

2. The trolley moves to the left

3. The 10 dots from the beginning.

4. The last 10 dots because the trolley moves fast and the dots is further apart

5. The trolley moves slower than faster. At the beginning of the ticker tape, the dots are near to each other and lastly the dots getting further.