AN INVESTIGATION ON STUDENT'S CONCEPTUAL UNDERSTANDING OF NEWTON'S THIRD LAW – FORCE IN EQUILIBRIUM AND ATTITUDES IN PHYSICS USING EQUIFORCE KIT WITH STAD COOPERATIVE LEARNING

CHONG CHIN LU

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Chong Chin Lu
.....
(CHONG CHIN LU)

Alamat Tetap: Blk F 00-35, Rainfield Court,
Jln Nosoob, 88300 P'pang, Sabah.

Tarikh : 8 JULAI 2013

Disahkan oleh

.....
(Dr Sopiah Abdullah)
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DECLARATION

I, Chong Chin Lu, hereby declare that this dissertation is my own original work and has not been submitted anywhere. Further, I have acknowledged for every source I have used or cited in the reference section.

CHONG CHIN LU
PT2011-7297C
SCHOOL OF EDUCATION AND SOCIAL DEVELOPMENT
DATE: 8 JULY 2013

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ABSTRACT

The purposes of present study were to (i) investigate the effects of incorporating a manipulative material - 'EquiForce Kit' (EFK) in a Student Team-Achievement Division (STAD) classroom; and to (ii) examine students' attitudes toward Physics using EFK. A total of 77 students who take Physics subject in two secondary schools around Penampang and Kolombong district in Sabah were assigned into STAD (control group) and STAD-EFK (treatment group). Force in Equilibrium Concept Test (FECT) and Attitudes in Physics were used to collect data. The data was then analyzed using independent and paired sample t-test with SPSS 16.0. The finding indeed showed better improvement of conceptual understanding of Force in Equilibrium in STAD-EFK group than in STAD group, but the changes were not significant. Besides, the attitudes survey also indicated no significant difference in pre- and post-test of STAD-EFK group.

Key Words: Forces in Equilibrium, Conceptual Understanding, Attitudes.

ABSTRAK

Kajian Penggunaan EquiForce Kit Dengan Pembelajaran Koperatif STAD Terhadap Kefahaman Konseptual Hukum Newton Ketiga - Keseimbangan Daya Dan Sikap Dalam Fizik Pelajar

Kajian ini bertujuan untuk mengkaji (i) kesan penggunaan bahan manipulasi – 'EquiForce Kit' (EFK) yang disepadukan dalam kelas Student Team-Achievement Division (STAD); dan (ii) sikap pelajar terhadap Fizik dengan penggunaan EFK. Sample kajian ini terdiri daripada 77 orang pelajar daripada sekolah menengah sekitar Penampang dan Kolombong ditetapkan sebagai kumpulan STAD (kawalan) dan STAD-EFK (rawatan). Ujian Konsep Keseimbangan Daya (FECT) dan Attitudes in Physics digunakan untuk mengumpul maklumat dan seterusnya dianalisis menggunakan ujian-t bagi dua kumpulan yang tidak bersandaran dan ujian-t bagi dua kumpulan yang bersandaran. Sesungguh dapatan kajian menunjukkan peningkatan yang lebih tinggi bagi kumpulan STAD-EFK berbanding dengan kumpulan STAD dalam ujian kefahaman Force in Equilibrium, malah perbezaan ini tidak ketara. Di samping itu, ujian sikap terhadap Fizik juga menunjukkan tiada perbezaan yang signifikan dalam ujian pra dan pasca bagi kumpulan STAD-EFK.

Kata Kunci: Keseimbangan Daya, Kefahaman Konseptual, Sikap.

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CAT	Concept Achievement Test
EFK	EquiForce Kit
FCI	Force Concept Inventory
FECT	Force in Equilibrium Concept Test
FMCE	Force – Motion Concept Evaluation
KBSM	Integrated Curriculum for Secondary Schools
JSU	Test Specification Table
NSKS	Nature of Scientific Knowledge
NTM	New Teaching Method
PBL	Problem –Based Learning
Post-FECT	Posttest for Force in Equilibrium Concept Test
Pre-FECT	Pretest for Force in Equilibrium Concept Test
SPSS 16.0	Statistical Package for Social Sciences Version 16.0
STAD	Students Team-Achievement Divisions
STAD-EFK	Students Team-Achievement Divisions with EquiForce Kit
ZPD	Zone of Proximal Development

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Physics is a field of knowledge that is mainly based on individual experiences and what happened in daily practices. However, students' view of concept is normally not exactly the same with the real science concept. Their thinking of Science at that particular moment can be called as intuitive belief which is actually constructed inside them according to what they have experienced. Therefore this intuitive belief held by students before entering their first Physics lesson, has been proved to be one of the major difficulties in learning Physics (Eryilmaz, 2002). Students started to learn physics with their well-established common sense beliefs about physical world from what they had discovered since the first day they came to the world (Hestenes, Wells & Swackhamer, 1992; Dykstra, Boyle & Monarch, 1992). A student would not be able to grasp the correct concept if one's conception framework is not in phase with the teacher. Eventually, the student pre-existed incorrect beliefs remain unchanged, hence identified as 'Misconception', 'Alternative Conception', or 'Preconception' by many researchers (Hestenes, Wells & Swackhamer, 1992; Smith, dissessa & Roschelle, 1993; Eryilmaz, 2002; Bayraktar, 2007). Over few decades, researches have revealed that most students entered Sciences classes with their own perceptions which, in fact, were not in line with scientific views (Treagust & Duit, 2008). Furthermore, students will usually resist to a change of perceptions which seemingly, for them, are more logical than the correct one (Bayraktar, 2007) even after the lesson. Thus, students' preconception is generally a

major obstacle in physics learning and this is urged to be investigated in order to find out an optimum solution.

Throughout the years, many researchers were trying to figure out teaching strategies that capable to overcome this problem, especially constructivism that stressed on students' experiences in understanding the real concept (Nilsson, Pendrill & Pettersson, 2004; Nabilah Abdullah, 2009; Ogunleye & Babajide, 2011). For example, Problem-Based Learning integrated with Cooperative Learning approach (Ahmad Hadi Ali & Siti Nur Kamariah Rubani, 2009; Fauziah Sulaiman, 2010; Ates & Eryilmaz, 2011). From those studies, Cooperative learning has proven to be effective in a classroom. Students may learn from their peers through their own activities and interaction (Shimazoe & Aldrich, 2010). In addition, Eryilmaz (2002) also claimed that the conceptual change discussion which implies Cooperative Learning has significant effect on reducing misconception and improving achievement in Force and Motion.

Other than that, the matter of students' attitudes toward Science is also another factor that principally influences students' learning in Science. Students' attitudes and interests have a significant contribution in students' Physics learning (Normah & Salleh, 2006). In different country, students develop vary attitudes toward Science. In comparison, students in developing countries generally hold better positive attitudes than in developed countries (Riffat-Un-Nisa Awan *et al.*, 2011). The Physics subject is generally treated as an elite discipline and it is conceptually hard (Erdemir, 2009). Due to this reason, students prefer not to choose Physics course when compared to Biology and Chemistry, especially for girls (Riffat-Un-Nisa Awan, 2011). As an addition, Erdemir (2009) have figured out that plenty of developed countries often failed to achieve the target goal in Physics compared to other Science discipline.

Therefore, the present study is aimed to study the conceptual understanding of students in Force and students' attitudes toward Physics.

1.2 BACKGROUND

Many studies have done on conceptual understanding in Physics over the year, particularly amongst elementary and high-school pupils (Trumper, 1998), as well as the pre-service Physics' teachers (Trumper, 1998; Bayraktar, 2007; Saglam-Arslan & Devecioglu, 2010). The students are averagely found to be holding incorrect Physics concepts, especially when it is related to 'Forces'. In this study, the concept of 'Forces in Equilibrium' is highlighted. In order to understand the concept and reasoning in balanced force, Newton's First Law and Newton's Third Law should be first introduced in the lesson. From previous studies, there are two significant misconceptions of students in Newton's Third Law: (i) There may not be necessary a reaction force for every each action force; and (2) Action and reaction may not happen at once (Kara, 2007; Crowe, 2009). In Crowe (2009), there was also evidence showed that students not even able to interpret an action and reaction pair in the picture of a monkey sitting on the ground, as well as the net force. Besides, Trumper (1998) analyzed students' view of Forces in three different areas of Identifying Forces, Adding Forces, Force and Motion, and found that students mostly failed in identifying the direction of forces. At the same time, students were also confused to affirm the balances forces that acting on an object during uniform motion.

From most of the studies, we noticed that remedying misconception and conceptual change would not happen naturally. Students' understanding would change if different types of learning activities or materials have been integrated in their learning process. Concept of Forces in Equilibrium is quite abstract for new learners. This

happens when they have to identify the direction of forces. Most of the students were unable to imagine balanced forces or identifying unbalanced forces. This finding was supported by Trumper (1998) in his journal 'The Need for Change in Elementary-school Teacher Training: The Force Concept as an Example'. Therefore, in order to neutralize the interference of misconceptions, teacher would have to confront students' misconception in the instruction (Smith, diSessa and Roschelle, 1993). Their misconceptions would be eliminated if the disparity of real concept and misconception was totally explicit. However, Bayraktar (2007) and Wood (2011) share different view by claiming that conceptual change did not always happen though the students were presented with some plausible evidences. At the same time, Bayraktar (2007) concluded that majority of the misconceptions held by college pre-service teachers remain unchanged, even the finding showed positive increment in Mechanic Physics.

Other than conceptual understanding, student's attitudes toward Physics also caught a lot of attentions (Duda& Garrett, 2008; Ahmad Nurulazamet.al., 2010; Hirca, Çalik, & Seven, 2011; Milner-Bolotin *et al.*, 2011). The finding of Kaya & Boyuk (2011) indicated that students' attitudes toward Physics are depended upon students' grade and ages, but not gender. Moreover, Milner-Bolotin *et al.* (2011) studies stressed that educational background of the students has significant influence on students' attitudes and their conceptual knowledge.

Therefore, this study is attempted to examine the effect of different approaches in remedying students' pre-conception. In the meantime, the study is also tried to find out the impact of applied approaches in students' attitudes toward Physics.

1.3 PROBLEM STATEMENT

In order to eliminate students' misconceptions, their conceptual framework has to be reconstructed. Conceptual understanding of a student can be built by experiences or hands-on activities. Constructivist believed that knowledge is constructed in the learner's mind (Bodner, 1986). This constructed knowledge is actually organized from the learner experience on the basis of one's pre-existing mental structures. According to Nersessian (1999), there are three generative of conceptual change in Science, which are (i) creating analogies, (ii) employing visual representations, and (iii) thought experimenting. According to Treagust & Duit (2008), students may use different method to make the difficult concept comprehensible based on the conceptual change learning theory. Shaharom & Faizah (2010) suggested that using a suitable teaching material in learning Physics is much more important. This is because the teaching material such as concrete manipulative enable student to communicate with the abstract content. Thereupon, learning could occur in a better way through any combination of verbal, textual, pictures, or physical objects.

In the present study, researcher attempted to integrate manipulative material and supplement worksheet in a cooperative classroom. A manipulative material not only helps student to understand the learning concept, but also as a beneficial in making a problem more readily accessible in long-term memory (Moreno, Ozogul & Reisslein, 2011). Previous study that conducted by Jonassen, Strobel and Gottdenker (2005) argued that students' conceptual change are mostly affected by model-based reasoning and this model building was found to be a very powerful tool in conceptual change. Besides, Newcomer and Steif (2008) carried out a study and proved that students who practice the "Principle of Static Equilibrium" in daily basis had improved their

understanding in "Forces in Equilibrium". In later years, Gire, Carmichael, Chini, Rouinfar & Rebello (2010) provided evidence that physical manipulative affects students better in understanding concept of effort force, distance pulled and mechanical whereas the virtual manipulative is more effective on the concept of work in pulley system.

In this study, a learning kit consisted manipulative material is developed and it is also implied Gestalt's Visual Perception and Vygotsky's Sign System. The manipulative material is indeed acted as a visual representation. Lately, Geelan and Murkherjee (2011) claimed that scientific visualizations are popular amongst teacher to a certain degree. Nevertheless, they found that using or not using the visualization tool has no impact in learning key concept. Therefore, Akarsu (2011) suggested that Physics educators should dig more on student conceptual understanding and develop more beneficial teaching tool.

From another perspective, conceptual change could also occur in a Cooperative Classroom. Crowe (2009) suggested that peer interaction in Physics classroom enhanced students' conceptual understanding. Students score better in the treatment classroom than traditional classroom in Force-Motion Concept Evaluation (FMCE) test. Current study integrated the manipulative material with Student Teams-Achievement Divisions strategy in a Physics classroom. This strategy been proven by many scholars that to be effective in a classroom (Adesoji & Ibraheem, 2009; Ahmad & Mahmood, 2010; Khan & Inamullah, 2011).

Regarding to students' attitudes toward Physics, Selcuk (2010) has conducted an experimental research and concluded that the Project Based Learning Physics instruction has positively impacted the students in term of interest and achievement in Physics. There were also many similar studies conducted by Erdemir (2009), Ahmad Nurulazam

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