PROMOTING INFORMAL REASONING SKILLS AND UNDERSTANDING OF INTERACTION AMONG LIVING THINGS THROUGH SOCIO-SCIENTIFIC (SSI) BASED ACTIVITIES

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By

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LIST OF ABBREVIATIONS

SSI	-	Socio-Scientific Issues
UPSR	-	Ujian Pencapaian Sekolah Rendah
SCT	-	Science Concept Test
SCP	-	Science Concept Pre-test
SCPT 1	-	Science Concept Post Test 1
SCPT 2	-	Science Concept Post Test 2

MENINGKATKAN KEMAHIRAN MENAAKUL SECARA BUKAN FORMAL DAN KEFAHAMAN TENTANG INTERAKSI ANTARA BENDA HIDUP MELALUI AKTIVITI BERASASKAN ISU - ISU SOSIO - SAINTIFIK (SSI).

ABSTRAK

Penyelidikan ini bertujuan untuk mengkaji keberkesanan mengintegrasikan aktiviti berasaskan isu – isu sosio-saintifik (SSI) dalam kurikulum sains rendah untuk meningkatkan kemahiran menaakul secara bukan formal dan kefahaman tentang interaksi antara benda hidup. Dalam kajian ini sebanyak lapan aktiviti berasaskan isu – isu sosio-saintifik telah digunakan dan seramai 68 (N= 68) orang murid daripada dua kelas dari sebuah sekolah rendah telah mengambil bahagian. Aktiviti berasaskan isu – isu sosio-saintifik ini, telah disediakan berdasarkan teori kontruktivis yang menekankan penggunaan pelbagai teknik seperti teknik menyoal, perbincangan secara kumpulan kecil dan keseluruhan kelas. Dengan menggunakan kaedah '*one-way repeated measure*' kefahaman murid tentang interaksi antara benda hidup diukur secara kuantitatif, menggunakan Ujian Konsep Sains (SCT) sebanyak tiga kali: Pra Ujian Konsep Sains; Ujian Pasca Konsep Sains 1(selepas aktiviti yang keempat) dan Ujian Pasca Konsep Sains 2 (selepas aktiviti yang kelapan). Kemahiran menaakul secara bukan formal murid diukur dengan kaedah kualitatif, mengunakan soal selidik terbuka selepas setiap aktiviti. Hasil dapatan untuk kefahaman menunjukkan bahawa aktiviti – aktiviti berasaskan isu – isu sosio-saintifik ini telah meningkatkan kefahaman murid [F (1.313, 84.015) = 189.8; p = 0.000, eta = 0.748] secara signifikan. Hasil dapatan soal selidik menerusi lapan aktiviti berasaskan isu – isu sosio-saintifik ini dapat meningkatkan kemahiran menaakul secara bukan formal murid dalam tahap

penaakulan, mod penaakulan dan mod membuat keputusan. Bagi tahap penaakulan, murid – murid dapat memberi lebih hujah sokongan, hujah bantahan dan hujah justifikasi untuk menyokong pandangan mereka. Dari segi mod penaakulan, para murid menghasilkan lebih hujah - hujah dari aspek mod sosial, ekologi, ekonomi dan sains. Tambahan lagi, murid – murid dapat membuat keputusan berasaskan bukti daripada keputusan spontan. Penulisan jurnal reflektif murid juga dapat memberi maklum balas yang positif seperti, aktiviti – aktiviti tersebut adalah menarik, murid – murid suka akan pembelajaran berasaskan teknik ini dan berharap akan aktiviti sebegini lebih banyak dijalankan.

PROMOTING INFORMAL REASONING SKILLS AND UNDERSTANDING OF INTERACTION AMONG LIVING THINGS THROUGH SOCIO-SCIENTIFIC (SSI) BASED ACTIVITIES.

ABSTRACT

This study was aimed to investigate the effectiveness of integrating socio-scientific based activities into primary science curriculum in promoting informal reasoning skills and understanding of interaction among living things. For this purpose, eight SSI activities were used to improve pupils' understanding of interaction among living things and informal reasoning skills. A total of 68 (N= 68) year six pupils who belong to two different classes from a primary school participated in this study. The socio-scientific activities were designed based on constructivist learning approach using questioning, small group and whole class discussions techniques. Employing one-way repeated measure design pupils' understanding on interaction among living things was measured quantitatively using Science Concept Test (SCT) which was administered at three different times: pre-test; post test 1(after 4^{th} activity) and post test 2 (after 8^{th} activity). Pupils' informal reasoning skills were measured qualitatively in a progressive manner using open ended questionnaire after each activity. The outcome of one-way repeated measure ANOVA shows that socio-scientific activities improved pupils' understanding is significant [F (1.313, 84.015) = 189.8; p = 0.000. eta = 0.748]. The open-ended questionnaire responses obtained from the pupils throughout all eight activities shows that the SSI activities improved their informal reasoning skills in terms of reasoning levels, reasoning modes and decision making modes. The pupils tend to use more supportive arguments, counterarguments and constructed more rebuttals in supporting their claims. In

terms of reasoning modes pupils produced more social, ecological, economic and science oriented arguments. Additionally, more pupils tend to make evidence based decisions than intuitive decisions. Furthermore, pupils through reflective journal writing provided positive feedbacks such as the activities were interesting, they liked the lessons and expecting for this kind of teaching to be implemented more frequently.

CHAPTER ONE

INTRODUCTION

1.0 Introduction

Education system in Malaysia aimed to produce citizens equipped with knowledge, moral values, personal wellbeing and also the ability to contribute to the betterment of the family, society and nation. Malaysian education system develops potential of individuals in a holistic and integrated manner, so as to produce individuals who are intellectually, spiritually, emotionally and physically balanced and harmonious based on a firm belief in and devotion to God (CDC, 2006).

Specifically, science education in Malaysia nurtures science and technology culture by focusing on the development of individuals who are competitive, dynamic, robust and resilient and able to master scientific knowledge and technological competency (CDC, 2003). Generally, in primary school science classrooms, pupils are encouraged to apply science process skills, thinking skills and thinking strategies for thoughtful learning through investigative learning processes (CDC, 2003). This effort was further heighten with the introduction of new curriculum.

A new curriculum, Kurikulum Standard Sekolah Rendah (KSSR) was introduced and implemented beginning from 2011, with the intention to develop the 4R skills: reading, writing, arithmetic and reasoning skill (CDC, 2010). The

emphasis is no longer just on the importance of acquisition of knowledge, but also on developing higher-order thinking skills. The KSSR curriculum requires every child to master a range of important cognitive skills, including problem-solving, reasoning, creative thinking, and innovation skills (CDC, 2012b).

Socio-scientific issues (SSIs) are complex, open-ended, often include contentious dilemmas with no definite answers and constructed from multiple perspectives (Sadler et al., 2004). In the context of curriculum such as KSSR which intend to improve high order cognitive skills, reasoning and problem solving skills, Sadler (2004) asserted that integrating SSIs would be one of the effective approaches. It was reported that integrating SSIs in science curriculum enhances learning and critical thinking of students (Burek, 2012). SSIs also improve students' content knowledge, decision making skills, argumentative skills and attitude towards environment (Salvato & Testa, 2012). On the other hand, it is also evident in Nuangchalerm (2010) and Wu and Tsai (2007, 2011) that students' informal reasoning can be improved using the SSI approach. Hence, in this study, SSIs activities have been integrated into primary science teaching and effectiveness of these activities in enhancing primary pupils' understanding of interaction among living things and informal reasoning was measured.

1.1 Background of the Study

As an initiative to transform the existing education beginning from 1983 Kurikulum Baru Sekolah Rendah (KBSR) was introduced. After 10 years of implementation in 1993, KBSR curriculum has been revised and renamed as Kurikulum Bersepadu Sekolah Rendah (KBSR). In addressing the aims of KBSR

in 1994, science has been introduced as core subject, replacing 'Alam dan Manusia' and taught beginning from year four in primary schools. This science curriculum was designed in such a way that it provides basic science knowledge and skills and also prepares the students to learn science at secondary level (CDC, 2003). In order to cater to the globalization of education and also for the education in Malaysia to be at par with other developed countries revised curriculum known Kurikulum Standard Sekolah Rendah (KSSR) was introduced in stages beginning from 2011 involving year one classes. Currently, KSSR science curriculum is in year five of the implementation. It is expected that KSSR science curriculum will entirely replace KBSR curriculum by the year 2016.

Inherently, the new curriculum focuses on developing scientifically literate individual. This is because a scientifically literate person would be able to use the scientific information to solve problems and make decisions for the health of their community (Burek, 2012). Sadler et al. (2007) further asserted that scientifically literate person possesses the ability to reason scientifically and also employs scientific knowledge and scientific ways of thinking for individual and social purposes.

Generally, the transformations in science are obvious in the aspects of key areas including curriculum documentation, curriculum design, curriculum organization, curriculum content, elements and focus. The key areas in KBSR science focused on communication, man and environment and self-development whereas KSSR science focuses on communication, spiritual, attitude and values, humanitarian, physical and aesthetical development, science and technology and physical and personal development. In sum, KSSR science focuses on producing

holistic individuals and values character building which aligns with our national educational philosophy (CDC, 2010).

In the KSSR curriculum 4R elements or reading, writing, arithmetic and reasoning skills are imparted at two levels: level one focuses on delivering scientific knowledge, innovative skills and technology skills whereas at level two the content is presented as two distinct components: technology and designing subjects (CDC, 2013a). At level two pupils are taught science concepts which in turn expected to improve their reasoning skills. Specifically the focus is on improving the ability to reason logically because this is the highest outcome the pupils need to achieve. In other words, the pupils with a good reasoning skills will be awarded a band six, which is the highest band in the school based assessment (CDC, 2012a, 2013a).

One of the science content that is included in the year six (level two) curriculum is interaction among living things (CDC, 2006). In this topic pupils will be taught on various ways of how animal lives, ways of interaction such as competition and cooperation among animals and plants, extinction of animals and plants and factors contribute to extinction of certain species of plants and animals (CDC, 2006). Additionally, this topic also focuses on the environmental destruction caused by the human activities. Specifically, this topic stresses on the value appreciation towards nature and other living things.

Reasoning skill promotes pupils' ability to give cause and effect and to reason logically and rationally to solve a problem (CDC, 2012b). Rather than encouraging exploration and generation of new ideas it also promotes critical, creative and innovative thinking skills, good questioning skills, curiosity,

cooperation and comparison (CDC, 2012b). Formal reasoning and informal reasoning are the two elements of reasoning skills (Wu & Tsai, 2007, 2011). Formal reasoning requires the rule of logic and mathematics whereas informal reasoning known as a rational process of constructing and evaluating arguments (Kuhn, 1993). Formal reasoning is always well defined, the premises are explicit however the informal reasoning are not well-defined and the premises will be the response to a complex issue that lack of clear-cut solutions (Wu & Tsai, 2007, 2011).

SSIs are described as social dilemmas with conceptual ties to science (Sadler et al., 2007). Inclusion of societal dimensions into teaching and learning science permits science to have a humanistic perspective. For instance, while teaching erosion and weathering to primary pupils on the real impact of erosion on the locals at Florida beach was included (Dolan et al., 2009). Students were asked to make judgment on socio-scientific issues particularly in genetic engineering issues using genetics content knowledge (Sadler & Fowler, 2006). Teaching with SSIs interests the pupils because science is taught in a relevant social context, increases critical thinking skills and enhance overall student learning by exposing the students to real-world scenarios (Zeidler et al., 2009). By focusing on environmental issues, students will not only begin to think critically about such issues, but also they will become more environmentally literate as well (Burek, 2012).

In a study conducted by Wu & Tsai (2007) involving 71 tenth grade students in Taiwan, assessing informal reasoning skills on nuclear energy usage reported that the students were able to process reasoning from multiple

perspectives and make evidence - based decisions. Another study conducted by Wu and Tsai (2011), on the high school students' informal reasoning skills about nuclear energy usage reported that student's believes about the justification of scientific knowledge, cognitive structures and their information processing mode were correlated with their reasoning ability.

1.2 Statement of the Problem

Reasoning skill is an important outcome of teaching and learning and the emphasis on inculcating these skills began as early as 1962 with publication of '*Scientific Revolution'* (Kuhn, 1962). The report that Malaysian students failed to meet a minimum proficiency level in the PISA and TIMSS assessments from year 2007 till today in science, obviously shows that our students are lacking in science content knowledge, application of science knowledge and reasoning skills as stated in our national educational blueprint (CDC, 2012b). This increasing stress to teach higher order thinking skills among our Malaysian students starting from primary education has further elucidated the need to include reasoning skills in teaching and learning process mainly in science education through the implementation of newly introduced system, KSSR (CDC, 2010). As to fulfill this requirement, reasoning skills was added as an important element in teaching and learning in KSSR implementation besides reading, writing and arithmetic skills (CDC, 2010).

Literature in science education depicts that there is a strong relationship between conceptual understanding in science and formal reasoning skills (Burek, 2012). In fact, besides fostering content knowledge, developing formal reasoning

skills were considered one of the goals for teaching STEM education (Bao et al., 2009). Owing to the notion, formal reasoning is an important criteria that determines the students understanding of scientific concepts, formal scientific skills have been included in the curriculum specification of the KSSR curriculum for primary science (CDC, 2012a). However, informal reasoning skills which require students to draw inferences or conclusion on everyday experienced ill defined problems such as climate change, extreme weather, and issues related to energy generally is still lacking (Wu & Tsai, 2011).

Tweney (1991) asserted that although the results obtained in the scientific researches through rational process of constructing and evaluating arguments and characterized by rules of logic and mathematics, the operation to derive to the results itself originate through informal reasoning. In other words, many of the reasoning tasks in the classroom are generally appear to be performed in an informal manner. Despite, being reported to be used significantly in a classroom context, review of literature indicates that considerable importance was hardly stressed on informal reasoning skills (Sadler, 2002; Kuhn, 1993). Informal reasoning can be improved by integrating SSIs in science education. It allows the students to process reasoning from multiple perspectives and make evidence - based decisions (Wu & Tsai, 2007). Other than that, student's belief about the justification of scientific knowledge, cognitive structures and their information processing mode were correlated with their reasoning ability (Wu & Tsai, 2011).

Several science educators have argued on the importance of integrating SSIs into teaching and learning of science (Driver et al., 2000; Koslto, 2001; Zeidler & Schafer, 1984). According to Driver et al. (2000), discussions involving SSIs in a classroom context will lead to the development of a responsible citizenry

capable of applying scientific knowledge in resolving emerging real world problem. However, the question is to what extend SSIs have been included in teaching and learning science? Yager (1996) claimed that SSIs not actually reflects on a new avenue in science education. He further illustrated that integration of societal issues into teaching and learning science has began since 1980s with emergence of Science, Technology and Society (STS) movement actively engaged in promoting STS in science education. However, this effort failed to gain much attention namely because of inconsistency in the approaches used to present the societal issues (Pedretti & Hodson, 1995). On the contrary, Driver et al. (2000) suggested that SSIs will be more appropriate and relevant to be presented as science-based issues that affect current living.

In a comparative cross-contextual study participated by 12–13 year old Chinese students it was found out that SSIs necessitates informal reasoning involving multi perspective thinking and moral judgment (Lee & Grace, 2012). Other than that, a construct based assessment developed by Rivet and Kastens (2012) to examine students' analogical reasoning using the physical dynamic model in earth science showed that this model which was developed based on SSIs allowed the students to display a wide range of analogical reasoning for all the construct levels.

Study conducted in Italy by Salvato and Testa (2012) with 14 to 15 years old students proved that the student's physics content knowledge improved when integrating SSIs in classroom. A comparative study was conducted by Dolan et al. (2011) on primary school children in Sweden and England using SSI specifically on global warming issue to explore how children talk about SSIs. They stated that,

the children successfully engaged with logical arguments, discussions and debates according to the repertoires. Other than that Dolan et al. (2009) in another study integrated SSI activities on earth science, life science and physical science for elementary students. They concludes that, SSI interests the students in learning science, improved their understanding of content knowledge and helped them to become a better critical thinker using informal reasoning and argumentation skills.

Among numerous primary science content, understanding interactions among living things is one of the important concept that the students require to master at primary level (Tomera, 2011; Graham & Skinner, 2013). This is because understandings of these concepts are necessary to scientifically comprehend the phenomena surrounding them in their everyday life. Despite being important various studies indicated primary students having numerous misconceptions about the interaction among living things (Guest, 2003). Besides primary students, misconceptions relevant to interaction between living things also prevalent among the primary pre-service teachers (Hudson, 2005). Hence, the topic of interaction among living things was chosen to be taught using SSI based activities in this study.

As various researches mentioned above, integrating SSI in science education generally results in improving knowledge or understanding of the pupils and in various field. However, a very limited study was done to prove the improvement of informal reasoning among primary pupils, especially in Malaysian context. Hence, in this study SSI activities were used as instructional strategy to teach the topic of interaction among living things. The effectiveness of

SSIs activities to promote pupils' understanding about interaction among living things and informal reasoning skills were investigated.

1.3 Purpose of the Study

The purpose of this study is to adapt SSI activities related on the interaction among living things into teaching and learning of primary science. Additionally, effectiveness of SSI activities in improving primary school pupils' informal reasoning skills and understanding about interaction among living things was measured.

1.4 Research Questions

This research was conducted to answer the following questions:

1. Is there any significant change in pupils' understanding about interaction among living things before and after completing the SSI activities?
2. How the pupils' informal reasoning changed throughout the eight SSI activities? Specifically in terms of
    - Reasoning levels: supportive arguments, counterarguments and rebuttal constructions.
    - Reasoning modes: social orientated arguments, ecological orientated arguments, economical orientated arguments and science orientated arguments.
    - Decision making modes: intuitive decision making and evidence based decision making.
3. What are the pupils' perceptions about the SSI activities?

1.5 Hypothesis

Based on the aforementioned research question following hypotheses were formulated.

$H0_1$: There is no significant difference in the Science Concept Pretest (SCP); Science Concept Post-Test 1 (SCPT 1) and Science Concept Post-Test 2 (SCPT 2) mean scores of primary pupils' understanding about interaction among living things.

1.6 Significance of the Study

SSIs activities proposed through this study will be beneficial to the primary science curriculum developers, primary science educators, primary science teachers and primary school pupils. For the curriculum developers, SSIs activities proposed through the study will be informative to be included in the curriculum specifications and in the training activities for the in-service teachers. These activities could be included as proposed activities to teach interaction among living things in year six science curriculum. Recently, the ministry is engaged in offering various in-service training for the teachers to educate them on the teaching approaches that can result in improving higher orders thinking skills of the learners. Perhaps, SSIs activities as suggested in this study will be viable approach to be included in the training.

For primary science teacher educators, SSIs activities suggested could be included as one of the pedagogical approach in primary science teacher curriculum. With this integration, pre-service teachers will gain experience on SSI-based teaching before entering real classroom. Additionally, current primary science teachers could adapt these activities in real teaching as the activities are suggested to be integrated without revamping the existing curriculum. The primary pupils, on the other will be benefited from the new interdisciplinary kind of teaching which is evident can improve their informal reasoning and understanding.

1.7 Limitation of the Study

In this study, it was reported that eight SSIs activities introduced in the teaching and learning of interaction among living things in primary science classroom improved pupils' understanding and informal reasoning skills. Introduction of eight activities in a curriculum reported to be sufficient to obtain expected changes. However more concrete evidence on the effectiveness will be noticed if more activities were implemented (Topcu et al., 2010). In other words more concreted evident could be obtained with increasing the duration of interventions with more activities.

In this study, the effectiveness of the treatment was reported based on the data obtained from one group of students in one school. Probably, the effectiveness of the treatment will be better established if the study conducted with two groups: control and experimental groups. This is because according to Shadish et al. (2002) the effectiveness of any kind of treatment is better reported using quasi-experimental design involving two groups.

Generalization of the findings of this study is limited because of the limited sample size. Despite Creswell's (2010) claim conducting any kind of experimental research with 30 sample would be sufficient, however to be able for the findings to be generalized more sample size is required. Hence, it is suggested for the study to be replicated in a different context in different schools.

1.8 Operational Definition

Socio-scientific issues (SSIs) – SSIs described as social dilemmas with conceptual ties to science (Fleming, 1986; Kolsto, 2001; Zeidler, 2003). These involve issues such as land development, deforestation, recycling, illegal hunting, illegal logging, global warming and various kind of pollution.

SSIs activities – Effective teaching within SSIs-based instruction requires teaching resources in addition to subject matter knowledge (Nuangcharlerm, 2010). SSIs activities are resource that includes teaching of subject matter about interaction among living things using appropriate societal issue as a platform. In this context the subject matter knowledge is interaction among living things while the SSIs activities are focusing on the societal issues such as land development, global warming, water pollution, plastic pollution, illegal hunting, illegal logging, deforestation and recycling.

Informal reasoning – Informal reasoning is recognized as a rational process of constructing and evaluating arguments (Wu & Tsai, 2007). It includes pupils' ability to use different decision making modes (intuitive, evidence based or position change), reasoning modes (social orientated arguments, ecological orientated arguments, economical orientated arguments and science and technology orientated arguments) and reasoning level (supportive argument construction, counterargument construction and rebuttal constructions) (Wu & Tsai, 2007, 2011). This study was referred to the work of Wu and Tsai (2007,

2011) to analyze the informal reasoning skills of the pupils including the same aspects of decision making modes, reasoning modes and reasoning quality with slight modifications and adaptations to suit the level of primary pupils. The position change under decision making modes was removed and not assessed since the questions assessing position change were removed from the questionnaire. Other than that, science and technology orientated arguments under reasoning modes was modified to science orientated arguments as the primary pupils are not exposed to the technology orientated much.

Understanding interaction among living things – Interaction among living things is a subject matter included in year six science curriculum (CDC, 2006). Understanding of interaction among living things involves acquisition of knowledge on some animals live in groups and others live in solitary; competition is a form of interaction among living things; responsibility of human beings in protecting endangered species and knowing the impact of humans' activities on environment.

1.9 Summary

Chapter one presented the introduction, background, statement of problem, purpose of the study, research questions, hypothesis, significant of the study, limitations and operational definitions involved in this study. Aspects presented in chapter one provides a good grounding to measure the effectiveness of SSIs activities in promoting informal reasoning skills and understanding interaction among living things.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The main aim of this study is to investigate the effectiveness of integrating socioscientific issues (SSIs) into primary science teaching in improving primary school pupils' informal reasoning skills and understanding of interaction among living things. For this purpose in this chapter review of literature that governs the implementation of this study will be provided. In detail this chapter will provide complete illustration of the content of primary science from year one to year six focusing on topic interaction among living things, a review of literature on SSIs, informal reasoning skills and two theories: dual process theory and constructivist learning theory which this study was based on. This chapter will end with providing the theoretical and conceptual framework that governs the study.

2.1 Primary Science Curriculum

Malaysian national educational philosophy generally aimed to develop the potential of individuals in a holistic and integrated manner to produce citizens who are intellectually, spiritually, emotionally, physically balance and harmonious (CDC, 2012b). Inherent to the national educational philosophy, the science curriculum intent to cultivate science and technology aspects by focusing on the development of individuals who are competitive, dynamic, robust and

resilient and able to master scientific knowledge and technological competency as required in the 21st century (CDC, 2003).

Kurikulum Standard Sekolah Rendah (KSSR), the newly introduced system in 2011 to replace the existing KBSR curriculum, focuses on nurturing science and technology elements beginning from level one (year one, two and three). The level one science curriculum focuses imparting scientific knowledge, and cultivating various 21st century skills inclusive of technology, innovation, scientific skills, ICT skills and thinking skills (CDC, 2010, 2011, 2012a). The aforementioned skills are emphasized through acquisition of 4Rs: reading, writing, arithmetic and reasoning skills and in numerals. Besides that, the curriculum also nurtures skills such as creativity, innovation, and entrepreneurship qualities (CDC, 2010). In addressing the aforementioned skills and knowledge, the curriculum has been organized into three themes: learning about living things; learning about world around us; and technology (CDC, 2010, 2011, 2012a).

The content of the level two curriculums generally focuses on application of 4R in addition to acquisition of complex skills, knowledge and values (CDC, 2010). For this purpose the contents are organized in the following five themes: investigating living things; investigating force and energy; investigating materials; investigating the earth and the universe; and investigating technology (CDC, 2013a, 2014, 2015).

Investigating living things introduces pupil to the basic understanding about life processes of humans, animals, plants and microorganism. Pupils learn about the special behaviors and characteristics of animals and plants survival (CDC, 2013a, 2014). Generally, the topic on interaction among living things

explores the understanding of the students about nature by introducing food chain, food web, energy levels in year five curriculum. In continuing this topic in year six, pupils will learn about the animals that live in groups and solitary, cooperation and competition among animals and plants, the extinct and endangered animals and plants, and the impact of human activities on the environment (CDC, 2014, 2015).

Learning of interaction among living things requires the pupils to reflect a deeper understanding about the science concepts and value the application of these knowledge in their everyday living. This requires the pupils to relate their scientific concepts to their daily life situations. However, due to the abstract nature of the concepts students usually unable to the see the relevance of the content learnt beyond the four walls of the classroom (Driver et al., 2000). These consequently resulted in the students developing various misconceptions about this topic and ultimately possess minimal understanding of the concepts (Adeniyi, 1985; Brody, 1991; Ozkan et al., 2004).

For instance, Brody (1991) recognized common misconceptions about understanding of pollution among forth, eight and 11th grade pupils' specifically in solid and toxic waste, air, soil and water pollution. Similarly, some common misconceptions on ecological concepts and principles were identified among Nigerian students in a junior secondary school by Adeniyi (1985). Besides, Ozkan et al. (2004) developed a list of misconceptions related to ecological concepts among 58 elementary students using conceptual-change-text-orientated instruction method and traditional teaching method.

Employing effective teaching methods were identified one of the approach to overcome the notion pupils' inability to relate with everyday living and consequently to improve their understanding (Taber &Taylor, 2009; Karpudewan et al. 2014; Karpudewan et al., 2015). For instance, Taber and Taylor (2009) integrated hands on science unit on global warming for eight weeks and these lessons reported to positively improved students' understanding of science of climate change. Karpudewan et al., (2015) has successfully used constructivist based greenhouse activities to improve students' understanding about climate change and global warming among primary school students. Besides the aforementioned initiatives presenting the science concept using societal issues or using SSIs activities was reported successfully improved students' understanding of science concepts such erosion, landslides, and food chain. Following these claims SSIs activities were used to teach the topic of interaction among living things in this study.

The theme on force and energy stresses on the basic physical quantities specifically, the principles of measurement, standard units and the importance of using standard units, and the calculations of length, area, volume, mass, temperature and time (CDC, 2003, 2013a). Through the theme of materials, pupils will be investigating on the natural and man-made materials. This theme includes the study of the states of matter, formation of clouds and rains, acid, alkaline and neutral substances. It also enables pupils to understand how things around them rust and how food is preserved (CDC, 2006, 2013a 2014, 2015). The theme of investigating earth and universe provides the understanding of the Earth, Moon, Sun, Constellations and Solar System as a whole (CDC, 2006, 2015). This theme also provides understanding about the effects of the earth, moon and sun

movements, occurrence of day and night, the phases of moon and eclipses (CDC, 2006).

Analysis of primary science curriculum presented above clearly highlights the fact that the nation is enthusiastically engaged in creating future society that would be able to manage and survive with the challenges and demand experienced in the globalised 21st century living. This includes challenges derived from destructive environmental issues; contemporary health issues such as propagation of dengue and ebola viruses; and securing the country's peace. Along with these aims, this study attempt to suggest ways of using relevant SSIs and integrate these issues into teaching and learning of primary science. SSIs will be presented as effective approach to improve pupils' understanding of science concepts and informal reasoning skill. This attempt will be made without adding on to the existing content rather these issues will be integrated in a way to present existing content to be socially relevant.

2.2 Socio-scientific Issues

'Socio-scientific Issues' (SSIs) described as social dilemmas with conceptual ties to science (Fleming, 1986; Kolsto, 2001; Zeidler, 2003). It is a kind of issue that has a basis in science and has a potentially large impact on society (Nuangchalerm, 2010) and according to Dolan et al. (2009) SSIs possess following characteristics: have a basis in science, frequently the issues are at the frontiers of scientific knowledge; involve forming opinions, making choices at personal or societal level; frequently media-reported; deal with incomplete information because of conflicting or incomplete scientific evidence, and

inevitably incomplete reporting; address local, national and global dimensions with attendant political and societal frameworks; involve some cost-benefit analysis in which risk interacts with values; may involve consideration of sustainable development; involve values and ethical reasoning; may require some understanding of probability and risk; and are frequently topical with a transient life. The SSIs include climate changes, and use of the genetically modified foods which are global in nature and air and water pollution, illegal logging that impacts the society and neighborhood which are more local in nature (Sadler, 2011).

Within the science education the focus to use SSI as context to teach science continued to arise in order to able the students to negotiate the challenges from the real issue impacting the society. Erborg et al. (2009) suggested SSI as new strategies that has a humanistic perspective serves as method that could be employed to improve students' interest to learn school science which is currently reported to be at very minimal (Osborne & Dillon, 2012). Following this claim, Dolan et al. (2009) have integrated SSIs in teaching and learning of fifth grade earth science lessons. In these lessons, hands-on activity on erosion was used to teach the concept of mechanical erosion for the students to understand the difference between erosion and weathering. Additionally, following this activity for the students to apply the concept of erosion learned in the earlier lesson a debate regarding beach erosion on a local Florida beach was used. According to Zeidler and Nichols (2009) integrating SSI into science curriculum using discussion and debate will help the students to develop their thinking skills such as analysis, inference, explanation, evaluation, interpretation and self regulation. Additionally, Zeidler and Nichols (2009) further stressed that SSI based teaching

also produces the students who are truth-seeking, open minded, analytical, systematic, judicious and increasingly confident in their reasoning.

The pedagogical relationships between the teacher and the students in a science lesson that employs SSI strategy in presented in figure 2.1 (Zeidler & Nichols, 2009). The teacher draws the lesson based on subject-matter knowledge, pedagogical content knowledge and based on the teacher's life experience. Based on the aforementioned experiences the teacher decides SSIs that could facilitate the delivery of science content. Students on the other hand personally involve in investigating the SSIs. The engagements results in students use and develop various skills such as subject matter knowledge, informal reasoning, decision making, character and reflective judgment, argumentation, moral reasoning and life experiences.

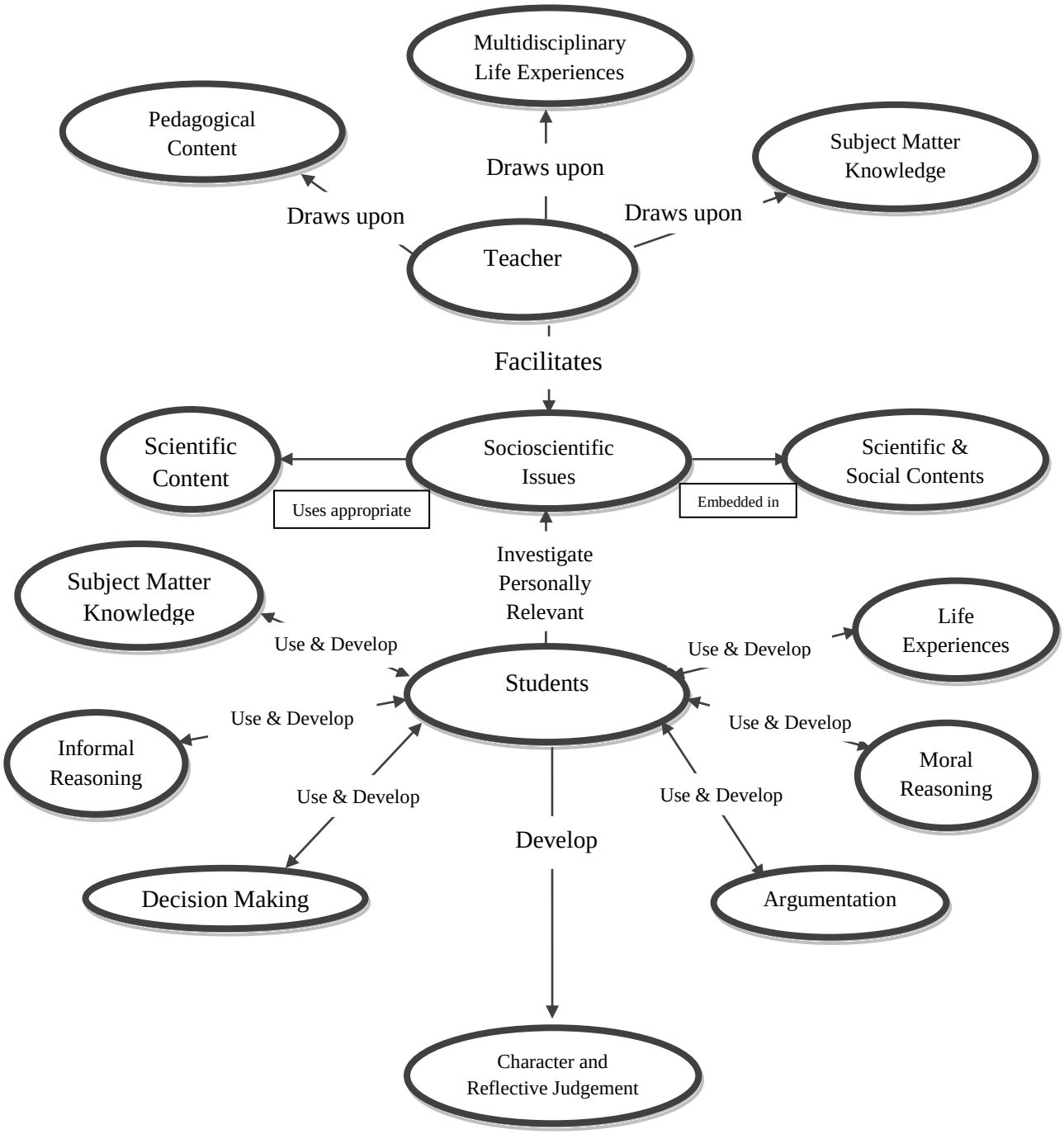

Figure 2.1: The pedagogical relationships between the teacher and the students. Adapted from Zeidler & Nichols (2009)

2.2.1 Past Researches Related to SSIs

Past studies related to SSIs indicate that integration of SSIs into teaching and learning across various levels has resulted in positive outcomes. This includes students' content knowledge of the issue, information processing skills, attitude towards the issue and adopting a position based on their views (Sadler et al., 2004). Additionally, Dolan et al. (2009) stated that SSI based instruction has been used to develop critical thinking and promotes scientific literacy (Nuangchalerm, 2010).

For instance Sadler and Zeidler (2004b) conducted a study aimed to explore the extent college students construct genetic engineering issues as moral problems. Basically, this study evaluated how students elicit their ideas, reactions and feeling regarding a series of gene therapy and cloning scenarios. The outcome of this study proves that students engaged in wide range of moral reasoning and decision making patterns and judgments. In other words these group students interpreted genetic engineering issues as moral problems and demonstrated decision making patterns consistent with moral construal.

Dolan, Nichols and Zeidler (2009) have infused three SSI activities in teaching earth science, life science and physical science for the fifth grade students in a primary classroom. Specifically, an activity entitled 'beach sand replacement' was integrated in earth science under the topic of beach erosion; another activity entitled 'the Canadian seal hunt' was infused into life science to teach the topic of food chain, food web and energy levels and the last activity entitled 'speed limits' was integrated into physical science to teach the topic of friction, velocity and mass. These activities were proved to students improve