LEARNING PROGRESSION OF ENERGY IN SECONDARY SCHOOL PHYSICS

AZLINAH BINTI ISPAL

THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR THE DEGREE OF MASTER OF EDUCATION

FACULTY OF PSYCHOLOGY AND EDUCATION
UNIVERSITY MALAYSIA SABAH
2016

UNIVERSITI MALAYSIA SABAH

BORANG PENGESAHAN STATUS TESIS

JUDUL: **LEARNING PROGRESSION OF ENERGY IN SECONDARY SCHOOL PHYSICS**

IJAZAH: **MASTER OF EDUCATION**

Saya, **AZLINAH BINTI ISPAL**, sesi pengajian **2013-2016**, mengaku membenarkan tesis sarjana ini disimpan di Perpustakaan Univeristi Malaysia Sabah dengan syarat-syarat seperti berikut:-

1. Tesis ini adalah hak milik Universiti Malaysia Sabah.
2. Perpustakaan Universiti Malaysia Sabah dibenarkan membuat salinan untuk pengajian sarjana.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tanda (/):

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA 1972)
☑	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan
☐	TIDAK TERHAD	

AZLINAH BINTI ISPAL

Disahkan oleh,
NURULAIN BINTI ISMAIL
LIBRARIAN
UNIVERSITI MALAYSIA SABAH

(Tandatangan Pustakawan)

(Prof. Madya Dr. Mohd. Zaki Ishak)
Penyelia

Tarikh : 7 September 2016

DECLARATION

I hereby declare that the material in this thesis is my own except for quotations, except equations, summaries and references, which have been duly acknowledged.

7 September 2016

.....

Azlinah Binti Ispal

MT1311007T

CERTIFICATION

NAME : **AZLINAH ISPAL**

MATRIC NO. : **MT1311007T**

TITLE : **LEARNING PROGRESSION OF ENERGY IN SECONDARY SCHOOL PHYSICS**

DEGREE : **MASTER OF EDUCATION**

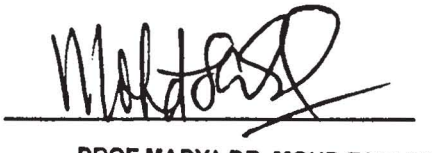
VIVA DATE : **14 JUNE 2016**

CERTIFIED BY;

SUPERVISOR

Associate Professor Dr. Mohd. Zaki Ishak

Signature



PROF MADYA DR. MOHD ZAKI ISHAK
PROFESOR MADYA
FAKULTI PSIKOLOGI DAN PENDIDIKAN
UNIVERSITI MALAYSIA SABAH

ACKNOWLEDGEMENT

بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

In the name of Allah, the Most Gracious and the Most Merciful.

Alhamdulillah, all praises to Allah for the strengths and His blessing in completing this thesis.

I would like to express my deepest gratitude and appreciation to my supervisor, Assoc. Prof. Dr. Mohd. Zaki Ishak from Faculty of Psychology and Education, University Malaysia Sabah. His office door was always open whenever I ran into a trouble spot or had a question about my research or writing. He consistently allowed this paper to be my own work, but steered me in the right direction whenever he thought I needed it.

I would also like to thank the Principal, teachers and students of a secondary school in Semporna, Sabah who were helped in ensuring this study can be carried out properly. Without their passionate participation and input, the study could not have been successfully conducted.

Finally, I must express my very profound gratitude to my mother, Hajah Mariah Binti Haji Mohd Tahir, my father Haji Ispal Bin Bakal, the whole family and my 'buddy support' for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. My dear son, Azwar Azhari, if you want to be strong, learn to fight alone. Thank you.

Azlinah Binti Ispal

7 September 2016

ABSTRACT

This study reported results on short-term learning progression of energy in secondary school physics. Energy concept is one of the most important ideas in all of science and useful for predicting and explaining phenomena in every scientific discipline. There are differences in how the energy concept is used across different disciplines. This matter triggers the alternative conceptions of energy not only among children, but students at university and society. This study employs a method called developmental maieutics in order to achieve the research objectives and to answer the research questions. All participants involved in two semi-structured interview sessions before and after the instructional intervention of energy concepts. There are five different situations of daily activities used as interview tools (interview-about-instance). Each interview transcribed and analysed. The cognitive level and energy concept development were analysed from both of the interviews. The development of cognitive was analysed based on Dawson-Tunik's cognitive development, while the energy concept is based on the sequence which starts from the forms and sources of energy, transformation of energy, energy transfer, and conservation of energy. The results triangulated with the reflection. Overall, all participants' conceptual knowledge increased to the higher levels, but not all of them achieved the abstract mappings level. The cognitive and conceptual knowledge of each participant developed at different rates in a different level and in this study, conservation of energy is the most difficult concept. The researcher discusses the implication of result in a few aspects. Finally, further steps in working towards a learning progression of energy are identified.

ABSTRAK

PEMBELAJARAN TERPERINGKAT TENAGA DALAM FIZIK SEKOLAH MENENGAH

Kajian ini melaporkan dapatan tentang pembelajaran terperingkat jangka pendek bagi konsep tenaga dalam fizik sekolah menengah. Konsep tenaga merupakan salah satu idea paling penting dalam semua bidang sains dan sangat berguna dalam menjangka dan menerangkan fenomena dalam setiap disiplin saintifik. Terdapat perbezaan bagaimana konsep tenaga digunakan merentasi pelbagai disiplin. Hal ini telah mencetuskan konsep-konsep alternatif terhadap tenaga bukan sahaja dalam kalangan kanak-kanak malah pelajar-pelajar di universiti dan masyarakat. Kajian ini menggunakan pendekatan kaedah yang dipanggil perkembangan maieutics untuk mencapai objektif-objektif kajian dan menjawab soalan-soalan kajian. tentang bagaimana pelajar mengembangkan kefahaman dalam konsep tenaga. Semua peserta kajian terlibat dalam dua sesi temu bual separa-berstruktur sebelum dan selepas intervensi pengajaran. Terdapat lima jenis situasi yang berbeza dalam aktiviti harian dijadikan bahan temu bual (temu bual-tentang-contoh). Setiap temubual disalin dan dianalisis. Perkembangan tahap kognitif dan konsep tenaga dianalisis daripada kedua-dua temu bual tersebut. Perkembangan kognitif dianalisis berdasarkan perkembangan kognitif Dawson-Tunik, manakala konsep tenaga berdasarkan jujukan yang bermula dari bentuk dan sumber tenaga, perubahan tenaga, perpindahan tenaga, dan keabadian tenaga. Hasil kajian ditriangulasi dengan refleksi. Secara keseluruhan, semua peserta kajian menunjukkan peningkatan pengetahuan dalam kognitif dan konsepsi ke tahap yang lebih tinggi, tetapi tidak semua daripada mereka mencapai tahap pemetaan abstrak. Perkembangan pengetahuan kognitif dan konsepsi setiap peserta kajian meningkat dengan kadar yang berbeza dalam aras yang berbeza dan di dalam kajian ini, konsep keabadian tenaga merupakan konsep yang paling sukar. Penyelidik membincangkan implikasi dapatan kajian dalam pelbagai aspek. Akhir sekali, langkah seterusnya dalam pembelajaran terperingkat konsep tenaga telah dapat dikenalpasti.

PUBLICATIONS

Azlinah Ispal & Mohd. Zaki Ishak. (2014). A literature review of students' conception of energy in secondary school physics. *Proceeding in International Postgraduate Conference Science and Mathematics*, University Pendidikan Sultan Idris, Tanjung Malim, Malaysia.

Azlinah Ispal, Mohd. Zaki Ishak, & Mohd. Asri Ispal. (2015). Developing conception of energy using the U slope. *Proceeding in International Conference of Physics Education*, Beijing, China.

Azlinah Ispal & Mohd. Zaki Ishak. (2015). Development conception of energy in secondary school physics. *Proceeding in Borneo International Conference on Science and Mathematics Education*, University Malaysia Sabah, Kota Kinabalu, Malaysia.

Azlinah Ispal, Mohd. Zaki Ishak, Mohd. Asri Ispal, & Noraini Abdullah. (2016). Energy concept development using the U slope. *Journal of Arts, Science, and Commerce*, 1 (1), 1-7.

AWARD

Bronze Medal in UMS Research and Invention Competition (PEREKA) 2015. University Malaysia Sabah.

TABLE OF CONTENTS

CHAPTER 2: LITERATURE REVIEW

CHAPTER 3: METHODOLOGY

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

The Malaysian aspiration to be an industrialized society can be said as highly depending on science and technology. The Malaysian science curriculum comprises three core science subjects and four elective science subjects. The core subjects are Sciences at primary, lower secondary and upper secondary school levels. Elective science subjects are offered at upper secondary school level and consist of Biology, Chemistry, Physics, and Additional Science. As articulated in the Malaysia Education Blueprint 2013 – 2025, Pre-School to Post-Secondary School, education in Malaysia is an on-going effort towards developing the potential of individuals in a holistic and integrated manner, who are knowledgeable, thinking critically and creatively.

In today's society, we are confronted with a wide range of energy usage issues such as electrical devices, hybrid or traditional cars, renewable energy and fossil. We need to understand what energy is and how it can be used wisely to reduce costs and pollution. In a school context, energy ideas are central to understanding the life, earth, and physical science (Herrmann-Abell & DeBoer, 2011). The term 'energy' has different meanings in everyday contexts. In a classroom, students often cannot link the term energy that they have learnt in physics to the term energy that they have learnt in biology or chemistry. On the other hand, they talk about energy being 'conserved' in physics, in biology 90% of energy 'lost' during the transfers between trophic levels while energy is often discussed as a 'flow' from natural sources to users in chemistry (Eisenkraft *et al.*, 2014). In addition, energy is already a part of the students' everyday language and experience (Lijnse, 1990; Trumper, 1990). It is not surprising to note that energy is a difficult concept for students to understand (Liu & McKeough, 2005; Neumann *et al.*, 2013).

Historically, many researchers and educators did not agree for the teaching of energy in early education (Rizaki & Kokkatos, 2013). For example, Warren (1982) stated that the concept of energy should not be taught until students have attained a high level of abstract reasoning, whereas Solomon (1983) and Trumper (1993) hold the opinion that teaching of energy should start at the primary school as soon as possible. Understanding energy in modern society is only possible with a sound insight into key basic ideas about the energy concepts. The teaching of energy worldwide is associated with the interest of experts and non-experts in particular for confronting the environmental problem. As a result of the seriousness of this situation, the energy concept is among the 'big ideas' established as a general framework in international monitoring studies, like PISA and TIMSS as well as in Science Education Standards around the world (Mullis *et al.*, 2009). For that reason, the United Nations have established a 'Decade of Education for Sustainable Energy Development' from 2005 to 2014 (Rizaki & Kokkatos, 2013) and continue as 'Decade of Sustainable Energy for All, 2014-2024' (United Nation, 2014).

Lehrmann (1973) argued that the traditional approach to introduce the energy concepts was via force and work, however Papadouris, Constantinou, and Kyratsi (2008) claimed that this approach cannot be accepted by another field of sciences. While a biologist uses energy to describe the relationships between organisms in an ecosystem for the atmosphere's warmth (Chabalengula, Sanders, & Mumba, 2012), a chemist interprets chemical reactions by tracking energy changes; a geologist uses the conservation of energy to build models that describe plate tectonics; a cosmologist relies on energy conservation when deducing the shape and structure of the universe; a particle physicist relies heavily on the idea that energy is conserved during interactions between subatomic particles and a dietician tracks the energy requirements of human body to help treat a diabetic patient. Thus, Richard Feynman goes on to say that, "It is important to realise that in physics today, we have no knowledge what energy is", (Feynman *et al.*, 2011).

What students should know about the energy concepts are the most important question to discuss among scientists, science education researcher and

teachers. Science teachers confront a complicated prospect when teaching students about energy. A teacher has to choose on how to present the concepts of energy in his/her discipline-centred classroom, but the concepts are still correct to the nature of energy. The failure of students in understanding the energy concepts does not only exist in the lower or upper secondary schools (Goldring & Osborne, 1994) but also occurs at the university level (Loverude, Kautz, & Heron, 2002).

After analysing all these situations, Neumann *et al.* (2013) carried out an empirical study towards a learning progression of energy. They developed a new measurement instrument, the *energy concept assessment*, and used it to investigate students' progression in understanding the energy concept in three different grade levels, Grades 6, 8 and 10. Ideally, learning progression is capable of describing how students develop a more expert understanding of a big idea of science such as energy over abroad (Smith *et al.*, 2006) and provides teachers with a framework for assessing the students' level of understanding of a core concept (Duschl, Maeng, & Sezen, 2011). Subsequently, learning progression is intended as a means to align content, instruction and assessment in order to provide students with the opportunity to develop a deeper understanding of the particular concept (Stevens, Delgado, & Krajcik, 2010).

1.2 Problem Statement

Science education researchers have indicated that there are serious difficulties in understanding energy and its related concepts among students of all ages (Bécu-Robinault & Tiberghien, 1998; Liu, Ebenezer, & Fraser 2002; Saglam-Arslan, 2010). For example, a high percentage of lower sixth form students do not understand the key concepts of energy, and little correlation has been found between their abilities and the application of qualitative knowledge and quantitative reasoning (Goldring & Osborne, 1994). Another essential point, Cheong *et al.* (2015) found that Bruneian students' understanding of alternative energy is low based on their two-tier instrument to diagnose students' understanding and alternative conception about alternative energy among Years 10 and 11 in Brunei.

Since energy are both a disciplinary core idea and a crosscutting concept (Eisenkraft *et al.*, 2014), students have to learn about energy in the contexts of biology, chemistry, physics, and the earth and environmental science. Simultaneously, they recognised that the energy of living systems (e.g. human and various organisms) and non-living systems (e.g. car, heat, nuclear) are the same. Due to these, students have been found to have alternative conceptions about energy concepts, and these refer to students' inappropriate conceptions that are not in tandem with the ones understood by the worldwide scientific community (Anderson, 2007). Students use the term energy in everyday lives well before learning about it in school and come to develop an intuition about it that may or may not map onto a scientific view of energy. If these alternative conceptions are not challenged, they can interfere with the development of new understanding (Duit & Treagust, 2003; Duit, Treagust, & Widodo, 2013).

A variety of quantitative and qualitative methods have been employed to identify the alternative conceptions of energy (e.g. Dawson-Tunik & Stein, 2004; Neumann *et al.*, 2013). Students' pre-existing knowledge acts as a very important role in further learning. In a related review of literature, misconception, misunderstanding, preconception, alternative framework, children science, spontaneous knowledge and naïve theory were defined and these terms have the same meaning (Calik & Ayas, 2005). Despite this terminology, in this study, the term 'alternative conception' is being used to figure out students' inappropriate understanding of energy based on the explanation made by Watts (1983)—personal and idiosyncratic ideas about energy, which are not simply just isolated misconceptions, but are parts, of a complex structure which provides a sensible and coherent explanation of the world from the students' point of view.

Students have to learn about energy even though "we have no knowledge of what energy is". Liu and McKeough (2005) proposed the hierarchically ordered conception of energy; this sequence is: perceiving energy as activities or abilities to do work; identifying different energy sources and forms; understanding the nature and processes of energy transfer; recognizing energy degradation; and realizing

energy conservation. Several researchers have reported a positive relation between the adequacy of students' scientific conceptions and level of cognitive development (Trumper, 1993). Consequently, an understanding of how scientific concepts are learned should be at the centre of the emerging cooperative efforts between cognitive scientists and educator (e.g. Dawson-Tunik & Stein, 2004, Saglam-Arslan, 2010).

The initial ideas of students bring into the classroom in the hope of building bridges between 'alternative conception' and 'scientific conception' knowledge state (Chi & Slotta, 1993; diSessa 1996; Slotta *et al.*, 1995). Considering the energy as a central of scientific disciplines including biology, chemistry, and physics, it can be assumed that these conceptions have been the main particular focus of many studies (e.g. Solomon, 1983; Trumper, 1993). Then, how is the student is able to understand a lesson aimed at presenting the scientific conception if the initial ideas may be very different? Thus, the relation between the conceptions of energy and cognitive development of students is to be studied in this study.

On the other hand, the disappointing results of international monitoring studies such as the Trends in International Mathematics and Science Study (TIMSS) have fuelled another general debate on the need for a sufficient level of scientific literacy and the necessity to improve the quality of science instruction in school (Duit, 2007). In Malaysia, through the book of Malaysia Education Blueprint 2013-2025, the results of TIMSS become a benchmark for learning mathematics and science for national education development. Malaysia's ranking for Science subject in TIMSS 2011 fell by an ever greater margin, from 21st in 2007 to 32nd (Ministry of Education, 2012). This result raises concerns at all levels, including teachers, administrators, the ministry and parents. Based on the TIMSS frameworks (Mullis *et al.*, 2009), the most important concept evaluated in science domain is energy. Notwithstanding, energy concepts are too imperative to understand by students in Malaysia.

1.3 The Aim of the Study

The aim of this study is to elaborate the development of cognitive and conceptual understanding of energy concepts in Form Four (16 years old) secondary school students. This study is based on the framework of short-term learning progression that is prevalent visually and verbally articulates how learning will typically move toward increased understanding for most students. To achieve this aim, the study will attempt to describe how students understand the energy concepts in physics that are consistent with physical science standard in the Malaysian Science Curriculum and Malaysian Physics Curriculum along the four strands: forms and sources of energy; transformation of energy; energy transfer; degradation and conservation of energy (Curriculum Development Centre, 2005f; 2006g).

This study is undertaken based on a number of the underlying reasons. Firstly, there is a growing interest of learning progression over the several decades. For example, Duschl, Schweingruber, and Shouse (2007) define a learning progression as "a sequence of successively more sophisticated ways of thinking about a topic over a period of time". Researchers have addressed learning progressions for many topics or skills (e.g. Lee & Liu, 2010; Plummer & Krajcik 2010; Songer & Gotwals, 2012). Moreover, learning progression may be interpreted in many ways; progressions may be viewed both as ideas evolving over the long-term or in the short-term (Alonzo & Steedle, 2009; Corcoran *et al.*, 2009) and function vertically across grades/years or horizontally within a school year (Dusch, Maeng, & Sezen, 2011). Consequently, this study is expected to contribute other findings and enhances the literature for further work towards learning progression of energy.

Secondly, prior knowledge had become one of the most important domains in science education research since the 1970s and thus affects the teaching and learning of energy (Duit, Treagust, & Widodo 2013). Students often held alternative conceptions that are incompatible with a scientific view (Anderson, 2007). Hence, the development of conceptual science is related to cognitive development (Dawson-Tunik & Stein, 2004; Trumper, 1993). Thus, this study is conducted for that reason,

as a theoretical lens in an effort to interpret the process of how cognitive and conceptual knowledge developed with respect to the energy concepts.

Lastly, based on Millar (2014)'s definition, there are two worlds or concepts of energy: in science, energy is an abstract, mathematical idea. It is hard to define 'energy' or even to explain clearly what we meant by the word; and the word 'energy' is widely used in everyday contexts, including many in which appear 'scientific'—but with a meaning which is less precise than its scientific meaning, and in which differs from it in certain respects.

1.4 Research Objectives and Research Questions

This study investigates students' learning progression with respect to the concepts of energy in secondary school physics. The researcher intends to use the learning progression framework to describe how scientific knowledge such as energy concepts can evolve from students' ideas (which radically differ from scientist's) to a deep and productive understanding of a scientific theory over a period of time. The researcher attempts to answer the research question regarding the following objectives:

Objective 1:

To investigate students' cognitive level and their alternative conceptions of energy before the instructional interventions.

i. What is the student's cognitive level of energy concepts before the instructional interventions?
ii. What are the alternative conceptions of energy that were held by students before the instructional interventions?

Objective 2:

To investigate students' cognitive level and their conceptual development of energy after the instructional interventions.

i. What is the student's cognitive level of energy concepts after the instructional interventions?

ii. To what extent the conceptual development of energy of students after the instructional interventions?

1.5 Significance of the Study

As has been interpreted by the scholars in science education, learning progression is capable to describe how students developed a more expert understanding of a big idea of science over abroad (Smith *et al.*, 2006). Therefore, the researcher intend to contribute to a new perspective in learning progression research, such as the researcher using the qualitative approach to broaden the literature review, generally on learning progression research and particularly in learning progression of energy research. This study may provide relevant information to the science education researchers, science teachers, and curriculum developers.

As the researcher mentioned earlier, the focus of the study is energy concepts. Research on students' conceptions revealed that students' ideas about energy before and also after formal class in school mainly reflect the use of energy in their life-world domain (Duit & Häußler, 1994). This situation will cause the inappropriate understanding of energy concepts. Therefore, this study will have implications to the participant's awareness of understanding of energy concepts, teaching and practice of science teachers and again to the curriculum developers.

1.6 Definition of the Terms

Here laid out the definition of the terms that have been used in this study:

i. Learning progression

Learning progression is a framework to see the progression of participants' understanding of energy, started from their alternative conceptions to the scientific conceptions over a period of time. In this study, the researcher viewed the

progression in short-term period and involved the same year/grade of participants (Berland & McNeill, 2010).

ii. Development

Development refers to the participants' development of cognitive level and conceptual understanding of energy. There are six stages or levels of development (developmental maieutics) that have been used as an indicator (Dawson-Tunik & Stein, 2004).

iii. Instructional intervention

Instructional interventions that have been used in this study were based on qualitative and naturalistic approaches (Merriam, 2001). The instruction is about the energy concepts in physics. The instructions consisted of learning activities to gain understanding of energy concepts among participants.

iv. Writing exercises

Reflection in this study is to support the deepening of reflection through formative assessment to reflect the students understanding of energy concepts. The tools used for reflective is writing exercises (Coulson & Harvey, 2013).

1.7 Scope and limitation of the Study

This study focuses on the energy concepts in physics. The energy concepts are too wide and had brought different meanings in different perspectives. Some advanced concepts of energy such as renewable and non-renewable energy growing rapidly discussed worldwide and the related research on this concept is too broad. Therefore, the researcher is aware that the scope of energy concepts is in secondary school physics only. This study is based on the qualitative methodology, therefore the researcher is aware that the main limitation of this study is that the findings or results cannot be extended to a wider population with the same degree of certainty with quantitative analysis.

REFERENCES

Adams, M. J., Treiman, R., & Pressley, M. (1998). Reading, writing, and literacy. In I. Sigel & A. Renninger (Eds.), *Handbook of child psychology*, **4**:275–355. Child psychology in practice, New York: Wiley.

Amin, A., Siwar, C., Hamid, A., & Huda, N. (2007). Pollution implication of electricity generation in Malaysia economy: An input-output approach, *Paper for Singapore AERC Conference*: 1-13.

AAAS (American Association for the Advancement of Science) (1993). *Benchmarks for science literacy.* New York, NY.

Alonzo, A. C., & Steedle. J. T. (2009). Developing and assessing a force and motion learning progression. *Science education*, **93**:389-421.

Anderson, C. W. (2007). Perspective on science learning. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of Research on Science Education*, 3-30. New York: Routledge.

Anderson, R. C., & Pearson, P. D. (1984). A schema-theoretic view of basic processes in reading. In P. D. Pearson (Ed.), *Handbook of reading research*, 255–291. New York: Longman.

Arons, A. (1999). Development of energy concepts in introductory physics courses. *American Journal of Physics*, **67**(12):1063-1067.

Ausubel, D. P. (1968). *Educational psychology: A cognitive view.* New York: Holt, Rinehart and Winston.

Bécu-Robinault, K., & Tiberghien, A. (1998). Integrating experiments into the teaching of energy. *International Journal Science Education*, **20**(1):99-114.

Berland, L. K., & McNeill, K. L. (2010). A learning progression for scientific argumentation: Understanding students work and designing supportive instructional contexts. *Science Education*, **94**(5):765-793.

Billing, D. (2007). Teaching for transfer of core/key skills in higher education: Cognitive skills. *Higher Education.* **53**, 483-516.

Bloom, J. W. (1995). Assessing and extending the scope of children's context of meaning: Context maps as a methodological perspective. *International Journal of Science Education*, **17**(2):167-187.

Bottorff, J. L., & Morse, J. M. (1994). Identifying types of attending: Patterns of nurses' work. *Image: Journal of Nursing Scholarship*, **26**:53-60.

Boyes, E., & Stanisstreet, M. (1991). Misconceptions in first-year undergraduate science students about energy sources for living organisms. *Journal of Biological Education*, **25**(3):209-213.

Bowden, J., Dall'Alba, G., Laurillard, D., Martin, E., Marton, F., Masters, G., et al. (1992). Displacement, velocity, and frames of reference: Phenomenographic studies of students' understanding and some implications for teaching. *American Journal of Physics*, **60**:262-269.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn: Brain, mind, experience and school*. Washington, DC: National Academy Press.

Briggs, D. C., Alonzo, A. C., Schwab, C., & Wilson, M. (2006). Diagnostic assessment with ordered multiple-choice items. *Educational Assessment*, **11**(1):33-63.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, **18**(1):32-41.

Broyles, D. (2006). What is energy? *Trafford Publication*, **22**. United States.

Bruner, J. S. (1966). *Towards a theory in instruction*. London: Belknap Press of Harvard University Press.

Bryman, A. (1989). *Research methods and organisational studies*. London: Unwin Hyman.

Bybee, R. W. (2014). NGSS and the next generation of science teachers. *Journal of Science Teacher Education*, **25**(2):211-221.

Calik, M., & Ayas, A. (2005). A comparison of level understanding of eighth-grade students and science students teachers related to selected chemistry concepts. *Journal of Research in Science Teaching*, **42**(6):638-667.

Carey, S., & Spelke, E. (1994). Domain-specific knowledge and conceptual change. In L. Hirsfeld, & S. Gelman (Eds.), *Mapping the mind: Domain specific in cognition and culture*, 169–200. Cambridge, MA: Cambridge University Press.

Case, R. (1991). *The mind's staircase: Exploring the conceptual underpinnings of children's thought and knowledge*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Catley, K., Lehrer, R., & Reiser, B. (2005). Tracing a proposed learning progression for developing understanding of evolution. *Paper Commissioned for the Committee on Test Design for K-12 Science Achievement Center for Education*, National Research Council.

Chabalengula, V. M., Sanders, M., & Mumba, F. (2012). Diagnosing students' understanding of energy and its related concepts in biological context. *International Journal of Science and Mathematics Education*, **10**:241-266.

Chacapuz, A. F., & Martins, I. P. (1987). High school students' ideas about energy of chemical reaction, in J. D Novak (Ed.) *Proceedings of the Second International Seminar on Misconceptions and Educational Strategies in Science Education*, **3**:60-68.

Champagne, A., Klopfer, L., & Anderson, J. (1980). Factors influencing learning classical mechanics. *American Journal of Physics*, **48**(12):1074-1079.

Cheong, I. P. A., Johari, M., Said, H., & Treagust, D. F. (2015). What do you know about alternative energy? Development and use of a diagnostic instrument for upper secondary school science. *International Journal of Science Education*, **37**(2):210-236.

Cheung, K. C., & Taylor, R. (1991). Towards a humanistic constructivist model of science learning: Changing perspectives and research implications. *Journal of Curriculum Studies*, **23**(1):21-40.

Chi, M. T., & Slotta, J. D. (1993). The ontological coherence of intuitive physics. *Cognition and Instruction*, **10**(2-3):249-260.

Chi, M. T. H., Slotta, J. D., & de Leeuw, N. (1994). From things to process: A theory of conceptual change for learning science concepts. *Learning and Instruction*, **4**:27–43.

Cleminson, A. (1990). Establishing an epistemological base for science teaching in the light of contemporary notions of the nature of science and of how children learn science. *Journal of Research in Science Teaching*, **27**(5):429-445.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education*. Routledge, Taylor and Francis Group, London and New York.

Constantinou, C. P., & Papadouris, N. (2012). Teaching and learning about energy in middle school: An argument for an epistemic approach. *Studies in Science Education*, **48**(2):161-186.

Corcoran, T., Mosher, F. A., & Rogat, A. (2009). *Learning progression in science: An evidence-based approach to reform*. New York, NY: Center on Continuous Instructional Improvement, Teachers College, Columbia University.

Coulson, D. & Harvey, M. (2013). Scaffolding student reflection for experience-based learning: a framework. *Teaching in Higher Education*, **18**(4):401-413.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches* (2nd Ed.). Sage, Thousand Oaks. CA.

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. Sage.

Curriculum Development Centre. (2002a). *Integrated Curriculum for Primary School, Curriculum Specification Science Year 1*. Ministry of Education, Malaysia.

Curriculum Development Centre. (2002b). *Integrated Curriculum for Primary School, Curriculum Specification Science Year 2*. Ministry of Education, Malaysia.

Curriculum Development Centre. (2003a). *Integrated Curriculum for Primary School, Curriculum Specification Science Year 3*. Ministry of Education, Malaysia.

Curriculum Development Centre. (2005a). *Integrated Curriculum for Primary School, Curriculum Specification Science Year 4*. Ministry of Education, Malaysia.

Curriculum Development Centre. (2006a). *Integrated Curriculum for Primary School, Curriculum Specification Science Year 5*. Ministry of Education, Malaysia.

Curriculum Development Centre. (2006b). *Integrated Curriculum for Primary School, Curriculum Specification Science Year 6*. Ministry of Education, Malaysia.

Curriculum Development Centre. (2002c). *Integrated Curriculum for Secondary School, Curriculum Specification Science Form 1*. Ministry of Education, Malaysia.

Curriculum Development Centre. (2002d). *Integrated Curriculum for Secondary School, Curriculum Specification Science Form 2*. Ministry of Education, Malaysia.

Curriculum Development Centre. (2003b). *Integrated Curriculum for Secondary School, Curriculum Specification Science Form 3*. Ministry of Education, Malaysia.

Curriculum Development Centre. (2005b). *Integrated Curriculum for Secondary School, Curriculum Specification Science Form 4*. Ministry of Education, Malaysia.

Curriculum Development Centre. (2006c). *Integrated Curriculum for Secondary School, Curriculum Specification Science Form 5*. Ministry of Education, Malaysia.

Curriculum Development Centre. (2005c). *Integrated Curriculum for Secondary School, Curriculum Specification Additional Science Form 4*. Ministry of Education, Malaysia.

Curriculum Development Centre. (2006d). *Integrated Curriculum for Secondary School, Curriculum Specification Additional Science Form 5*. Ministry of Education, Malaysia.

Curriculum Development Centre. (2005d). *Integrated Curriculum for Secondary School, Curriculum Specification Biology Form 4.* Ministry of Education, Malaysia.

Curriculum Development Centre. (2006e). *Integrated Curriculum for Secondary School, Curriculum Specification Biology Form 5.* Ministry of Education, Malaysia.

Curriculum Development Centre. (2005e). *Integrated Curriculum for Secondary School, Curriculum Specification Chemistry Form 4.* Ministry of Education, Malaysia.

Curriculum Development Centre. (2006f). *Integrated Curriculum for Secondary School, Curriculum Specification Chemistry Form 5.* Ministry of Education, Malaysia.

Curriculum Development Centre. (2005f). *Integrated Curriculum for Secondary School, Curriculum Specification Physics Form 4.* Ministry of Education, Malaysia.

Curriculum Development Centre. (2006g). *Integrated Curriculum for Secondary School, Curriculum Specification Physics Form 5.* Ministry of Education, Malaysia.

Dash, N. K. (1993). Research paradigms in education: Towards a resolution. *Journal of Indian Education* **19**(2):1-6.

Dawson-Tunik, T. L. (2004). "a good education is...." The development of evaluative thought across the life-span. *Genetic, Social and General Psychology Monographs*, **130**(1):4-112.

Dawson-Tunik, T. L. (2006). Stage-like patterns in the development of conceptions of energy. In X. Liu & W. J. Boone (Eds.), *Applications of Rasch measurement in science education*, 111-136.

Dawson-Tunik, T. L., & Stein, Z. (2004). *It Has Bounciness Inside! Developing Conceptions of Energy* at https://dts.lectica.org/PDF/Bounciness.pdf.

Dawson-Tunik, T. L., & Stein, Z. (2008). Cycles of research and application in education: Learning pathways for energy concepts. *Mind, Brain, and Education*, **2**(2):90-103.

de Lisi, R., & Staudt, J. (1980). Individual differences in college students' performance on formal operations tasks. *Journal of Applied Developmental Psychology*, **1**(3):201-208.

Denzin, N. K., & Lincoln, Y. S. (2005). The discipline and practice of qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.). *Handbook of Qualitative Research second edition.* Sage Publication, Inc. Thousand Oak.

Department for Education. (2013). *Science programs of study: key stage 3-National curriculum in England.* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/335174/SECONDARY_ national_curriculum_Science_220714.pdf

diSessa, A. A. (1996). What do "just plain folk" know about physics? In D. R. Olson & N. Torrance (Eds.), *The Handbook of Education and Human Development: New Models of Learning, Teaching, and Schooling*, 709-730.

Department of Energy. (2012). *Energy literacy: Essential principles and fundamental concepts for energy education.* Washington, DC: The US Department of Energy.

Driver, R., Asoko, H., Leach, J. Mortimer, E., & Scott, P. (1994). Constructing scientific knowledge in the classroom. *Educational Research.*

Driver, R. & Bell, B. (1986). Students' thinking and the learning of science: A constructivist view. *School Science Review*, **67**(240):443-456.

Driver, R., & Easley, J. (1978). *Pupils and paradigms: A review of literature related to concept.*

Driver, R., & Erickson, G. (1983). Theories-in-actions: Some theoretical and empirical issues in the study of students' conceptual frameworks in science. *Studies in Science Education*, **10**:37-60.

Driver, R., Guesne, E., & Tiberghien, A. (1985). *Children's idea in science.* Milton Keynes, England: Open University Press.

Driver, R., & Millar, R. (Eds.) (1986). Energy matters: *Proceedings of an invited conference: Teaching about energy within the secondary science curriculum.* Leeds (England): University of Leeds, Centre for Studies in Science in Science and Mathematics Education.

Duit, R. (1981). Understanding energy as a conserved quantity. *European Journal of Science Education*, **3**(3):291-301.

Duit, R. (1984). Learning the energy concept in school-empirical results from the Philippines and West Germany. *Physics Education*, **19**:59-66.

Duit, R., & Häußler, P. (1994). Learning and teaching energy. In P. Fensham, R. Gunstone, & R. White (Eds.), *The content of science*, 185-200. London: The Falmer Press.

Duit, R. (2002). Conceptual change – still a powerful frame for improving science teaching and learning? Paper presented in the third *European Symposium on Conceptual Change*, 26-28 June 2002, Turku, Finland.

Duit, R. (2007). Science education research internationally: Conceptions, research methods, domains of research. *Eurasia Journal of Mathematics, Science and Technology Education*, **3**(1):3-15.

Duit, R. (2014). Teaching and learning the physics energy concept. R. F. Chen *et al.* (Eds.), *Teaching and Learning of Energy in K-12 Education*, 67-85.

Duit, R., Roth, W. M., Komorek, M., & Wilbers, J. (2001). Fostering conceptual change by analogies—between Scylla and Charybdis. *Learning and Instruction,* **11**(4-5):283-303.

Duit, R., & Treagust, D. F. (2003). Conceptual change: A powerful framework for improving science teaching and learning. *International Journal of Science Education*, **25**(6):671-688.

Duit, R., Treagust, D. F., & Widodo. (2013). Teaching science for conceptual change: Theory and practice. In S. Vosniadou (Ed.), *International Handbook of Research on Conceptual Change,* 487-503. New York: Routledge.

Duncan, R. G., & Hmelo-Silver, C. E. (2009). Learning progression: Aligning curriculum, instruction, and assessment. *Journal of Research in Science Teaching*, **46**, 606-609.

Duschl, R., Maeng, S., & Sezen, A. (2011). Learning progressions and teaching sequences: A review and analysis. *Studies in Science Education*, **47**(2):123-182.

Duschl, R., Schweingruber, H., & Shouse, A. (Eds.). (2007). *Taking science to school: Learning and teaching science in grades K-8.* Washington, DC: National Academy Press.

Eisenkraft, A., Nordine J., Chen, R. F., Fortus, D., Krajcik, J., Neumann K., & Scheff, A. (2014). Introduction: Why focus on energy instruction? Chen, R. F. *et al.* (Eds.), *Teaching and Learning of Energy in K-12 Education*, 1-11.

Ernest, P. (Ed). (1994). Mathematics, education, and philosophy: An international perspective. *Psychology Press*, **3**.

Eryilmaz, A. (2002). Effects of conceptual assignments and conceptual change discussions on students' misconceptions and achievement regarding force and motion. *Journal of Research in Science Teaching*, **3**(9):100 –1015.

Feynman, R. P., Leighton, R. B., & Sands, M. (2011). *The Feynman lectures on physics* (New Millennium Ed.) New York, London: Basic Book, Perseus Running.

Fischer, K. W. (1980). A theory of cognitive development: The control and construction of hierarchies of skills. *Psychological Review*, **87**:477-531.

Fischer, K. W. (2009). Mind, Brain, and education: Building a scientific groundwork for learning and teaching. *Mind, Brain, and Education*, **3**(1):3-16.

Fischer, K. W., & Bidell, T. R. (1998). Dynamic development of psychological structures in action and thought. In W. Damon, & R. M. Lerner (Eds.), *Handbook of child psychology. Theoretical models of human development*, 5th Ed., 467-561.

Foucault, M. (1972-1977). *Power/knowledge: Selected interviews and other writings*, C. Gordon, Ed. New York: Pantheon.

Gage, N. L. (1989). The paradigm wars and their aftermath a "historical" sketch of research on teaching since 1989. *Educational Researcher*, **18**(7):4-10.

Gayford, C. G. (1986). Some aspects of the problems of teaching about energy in school biology. *European Journal of Science Education*, **8**(4):443-50.

Geertz, C. (1983). *Local knowledge: Further essays in interpretive anthropology.* New York: Basic Books.

Gilbert, J. K., & Pope, M. L. (1986). Small group discussions about conception in science: a case study. *Research in Science and Technological Education*, **41**(1):61-76.

Gilbert, J. K., & Watts, D. (1983). Concepts, misconceptions, and alternative conceptions: Changing perspectives in science education. *Studies in Science Education*, **10**:61-98.

Goldring, H. (1987). An energy module for liberal arts students. *Energy Resources in Science Education*, Ed D.F. Kirwan (Oxford: Pergamon), 141-5.

Goldring, H., & Osborne, J. (1994). Students' difficulties with energy and related concepts. *Physics Education*, **29**. IOP Publishing Ltd.

Goulding, C. (2004). Grounded theory, ethnography, and phenomenology: A comparative analysis of three qualitative strategies for marketing research. *European Journal of Marketing*, **39**(3/4):294-308.

Guba, E. G. (1990). *The paradigm dialog.* Sage Publications.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. *Handbook of Qualitative Research*, **2**:163-194.

Guzzetei, B. J., Snyder, T. E., Glass, G. V., & Gamas, W. S. (1993). Promoting conceptual change in science. A comparative meta-analysis of instruction intervention from reading education and science education. *Reading Research Quarterly*, **28**:116-159.

Gyberg, P., & Lee, F. (2010). The Construction of Facts: Preconditions for meaning and teaching energy in Swedish classrooms. *International Journal of Science Education*, **32**(9):1173-1189.

Hanson, R. (1993). Long-term effects of the Energy Source Education Program. *Studies in Educational Evaluation: SEE*, **19**(4):363-381.

Hatano, G., & Inagaki, K. (1998). Qualitative changes in intuitive biology. *European Journal of Psychology of Education*, **12**:111–130.

Helm, H. (1980). Misconceptions in Physics amongst South African students. *Physics Education*, **50**(15):92-105.

Herrmann-Abell, C. F., & DeBoer G. E. (2011). *Investigating students' understanding of energy transformation, energy transfer, and conservation of energy using standard-based assessment items.* Paper presented at the 2011 NARST Annual Conference, Orlando, FL.

Herrmann-Abell, C. F., & DeBoer, G. E. (2014). Developing and using distractor-driven multiple-choice assessment aligned to ideas about energy forms, transformation, transfer, and conservation. In R. F. Chen *et al.* (Eds.), *Teaching and Learning of Energy in K-12 Education*. Springer International Publishing Switzerland, 103-133.

Hess, K. (2010). Using learning progressions to monitor progress across grades: A science inquiry learning profile for PreK-4. *Science and Children*, **47**(6):57-61.

Hiatt, J. F. (1986). *Spirituality, medicine, and healing. Southern Medical Journal*, **79**:736-743.

Hill, C. E., Knox, S., Thompson, B. J., Williams, E. N., Hess, S. A., & Ladany, N. (2005). Consensual qualitative research: An update. *Journal of Counseling Psychology*, **52**:196-205.

Hinrichs, R., & Kleinbach, M. (2002). *Energy: Its use and the environment.* Boston, MA: Thomson Learning.

Holton, R., & Brush, G. S. (2001). *Physics, the human adventure: From Copernicus to Einstein and beyond (3rd Ed.).* New Brunswick, NJ: Rutgers University Press.

Howe, C., J., Tolmie, A., & Rodgers, C. (1990). Physics in the primary school: Peer interaction and the understanding of floating and sinking. European Journal of Psychology of Education, **5**(4):459-475.

Jin, H., & Anderson, C. W. (2012). Learning progression for energy in socio-ecological systems. *Journal of Research in Science Teaching*, **49**(9):1149-1180.

Johnson, C. V., Hayes, J. A., & Wade, N. G. (2007). Psychotherapy with troubled spirits: A qualitative investigation. *Psychotherapy Research*, **17**:450-460.

Juettner, B. (2005). *Energy.* The Heinle Reading Library, Academic Content Collection. Thomson Gale.

Kesidou, S., & Duit, R. (1993). Students' conception of the second law of thermodynamics: An interpretive study. *Journal of Research in Science Teaching*, **30**(1):85-107.

Kintsch, W. A. (2003). The role of knowledge in discourse comprehension: A construction integration model. In T. A. Polk (Ed.), Cognitive modeling, 5–47. Cambridge MA: MIT Press.

KMK (*Ständige Konferenz der Kultusminister der Länder*). (2005). German national education standards concerning physics for middle school graduation. In Schmidt, W. H., Houang, R., & Shakrani, S. (2009). *International Lessons about National Standard.* Thomas B. Fordham Institute, 42-44.

Krajcik, J., Drago, K., Shutherland, L. A., & Merritt, J. (2012). The promise and value of learning progression research. In S. Bernholt, P. Nentwig, & K. Nuemann, (Eds.), *Making it tangible—Learning outcomes in science education.* Münster: Wasmann.

Kuhn, T. (1959). *Energy Conservation as an Example of Simultaneous Discovery: Critical Problems in the History of Science*, M. Claggett (ed.) (Madison: University of Wisconsin Press), 321-356.

Kuhn, T. S. (1996). *The Structure of Scientific Revolutions, 3rd edition.* Chicago: University of Chicago Press, 10.

Kuzel, A. J. (1999). *Sampling in Qualitative Inquiry.* In BF Crabtrre and WL Miller (Eds.). Doing Qualitative Research (2nd ed.). Sage, Thousand Oaks, 33-45.

Lagemann, E. (2000). An elusive science: The troubling history of educational research. Chicago: University of Chicago Press.

Later, P. (2007). *Getting lost: Feminist efforts towards a double (d) science.* Albany, NY: SUNY Press, 164.

Lee, H. S., & Liu, O. L. (2010). Assessing learning progression of energy concepts across middle school grades: The knowledge integration perspective. Wiley Periodicals, Inc. *Science Education*, **94**:665-688.

Lee, L. S., Lee, Y. F., Altschuld, J. W., & Pan, Y. J. (2015). Energy literacy: Evaluating knowledge, affect, and behavior of students in Taiwan. *Energy Policy*, **76**:98-106.

Lehrman, R. (1973). Energy is not the ability to do work. *Physics Teacher*, **11**, 15.

Lehrman, R. (1982). Confused physics – a tutorial critique. *Physics Teacher*, **20**:519-23.

Lijnse, P. (1990). Energy between the life-world of pupils and the world of physics. *Science Education*, **74**(5):571-583.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage.

Lindeman, M., & Saher, M. (2007). Vitalism, purpose and superposition. *British Journal of Psychology*, **98**:33-44.

Linn, M. C., & Eylon, B. (2006). Science education: Integrating views of learning and instruction. In P. A. Alexander & P. H. Winne (Eds.), *Handbook of Educational Psychology*, 511-544.

Liu, X., Ebenezer, J., & Fraser, D. M. (2002). Structural characteristics of university engineering students' conception of energy. *Journal of Research in Science Teaching*, **39**(5):423-441.

Liu, X., & McKeough, A. (2005). Developmental Growth in Students' Concept of Energy: Analysis of Selected Items from the TIMSS Database. *Journal of Research in Science Teaching*, **42**(5):493-517.

Liu, X., & Park, M. (2014). Contextual dimensions of energy concept and implications for energy teaching and learning in R. F. Chen *et al.* (Eds.), Teaching and Learning of Energy in K-12 Education, Springer International Publishing Switzerland, 175-186.

Liu, X., & Ruiz, M. E. (2008). Using data mining to predict K-12 students' performance on large-scale assessment items related to energy. *Journal of Research in Science Teaching*, **45**(5):554-573.

Loverude, E. M., Kautz, H. C., & Heron, P. R. L. (2002). Students understanding of the first law of thermodynamics: Relating work to the adiabatic compression of an ideal gas. *American Journal of Physics*, **70**(2):137-148.

Lyst, A. M., Gabriel, S., O'Shaughnessy, T. E., Meyers, J., & Meyers, B. (2005). Social validity: Perceptions of check and connect with early literacy support. *Journal of School Psychology*, **43**:197-218.

Mak, S. Y., & Young, K. (1987). Misconceptions of teaching of heat. *School Science Review*, **68**(244):464-70.

Ministry of Education Malaysia (2012). *Malaysia Education Blueprint 2013-2025, Pre-School to Post-Secondary School.*

McIldowie, E. (1995). Energy transfer – where did we go wrong? *Physics Education*, **30**(4):228-230.

McMillan, J. H., & Schumacher, S. (1997). *Research in education: A conceptual introduction* (4th ed.) New York: Addision-Wesley.

Merleau-Ponty, M. (1979). *Consciousness and the acquisition of language.* Northwestern University Press.

Merriam, S. B. (2001). *Qualitative research and case study application in education. Revised and expanded from case study research in education.* Jossey-Bass Publishers. San Francisco.

Mezirow, J. (1991). *Transformative dimensions of adult learning.* San Francisco, CA: Jossey-Bass.

Millar, R. (2014). Teaching about energy: From everyday to scientific understandings. *School Science Review*, **96**(354):45-50.

Mohan, L., Chen, J., & Anderson, C. W. (2009). Developing a multi-year learning progression for carbon cycling in socio-ecological system. *Journal of Research in Science Teaching*, **46**(6):675-698.

Moon, J. A. (2004). *Reflection in learning and professional development.* New York, NY: Routledge Falmer.

Moon, S. M., & Rosselli, H. C. (2000). *Developing gifted programs.* In K. A. Heller, F. J. Mönks, R. J. Sternberg, & R. F. Subtonik (Eds.), International Handbook of Giftedness and Talent, 2nd Ed., 499-521. Amsterdam, Netherlands: Elsevier Science.

Morrow, S. L. (2005). Quality and trustworthiness in qualitative research in counseling psychology. *Journal of Counseling Psychology*, **52**:250-260.

Morrow, S. L. & Smith, M. L. (2000). Qualitative research for counseling psychology. In S. D. Brown & R. W. Lent (Eds), *Handbook of Counseling Psychology* 3rd Ed., 199-230. Hoboken, NJ: Wiley.

Morse, J. M. (1991). Strategies for sampling. In J. M. Morse (Ed.), *Qualitative nursing research: A contemporary dialogue* (127-145). Newbury Park, CA: Sage.

Morse, J. M. (2000). Determining sample size. *Qualitative Health Research*, **10**(1):3-5.

Moustakas, C. (1994). *Phenomenological research methods.* Thousand Oaks, CA:Sage.

Mullis, I. V. S., Martin, M. O., Ruddock, G. J., O'Sullivan C. Y., and Preuschoff, C. (2009). *TIMSS 2011, Assessment Framework.* TIMSS and PIRLS, International Study Center, Lynch School of Education, Boston College.

National Research Council. (2007). *Taking science to school.* Washington, DC: The National Academies Press.

National Research Council. (2012). *Framework for K-12 Science Education: Practices, crosscutting concepts, and core ideas.* Washington, DC: The National Academies Press.

Neumann, K., Viering, T., Boone, W. J., & Fischer, H. E. (2013). Towards a learning progression of energy. *Journal of Research in Science Teaching*, **50**(2):162-188.

Nicholls, G., & Ogborn, J. (1993). Dimensions of children's conceptions of energy. *International Journal of Science Education*, **15**(1):73-81.

Nordine J., Krajcik, J., & Fortus, D. (2010). Transforming energy instruction in middle school to support integrated understanding and future learning. *Science Education*, **95**(4):670-690.

Novak, J. D. (1988). Learning science and the science of learning. *Studies in Science Education,* **15**:77-101.

Novak, J. D., & Gowin, D. B. (1984). *Learning how to learn.* New York: Cambridge University Press.

Opitz, S. T., Harms, U., Nuemann, K., Kowalzik, K., & Frank, A. (2014). Students' energy concepts at the transition between primary and secondary school. *Research Science Education.* Springer.

Osborne, R. J., & Bell, B. (1983). Science teaching and children's view on the world. *European Journal of Science Education*, **5**(1):1-14.

Osborne, R. J., & Gilbert, J. (1980). A technique for exploring students' views of the world. *Physics Education*, **15**:376-379.

Palomo, J. R. (2008). Americans' knowledge about energy improving, but their energy IQ remains low. *Oil and Gas Journal*, **106**(36):37-39.

Papadouris, N., Constantinou, C. P., & Kyratsi, T. (2008). Students use of the energy model to account for changes in physical systems. *Journal of Research in Science Teaching*, **45**(4):444-469.

Patton, M. Q. (2002). *Qualitative research & evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage.

Petersson, G. (2002). Description of cognitive development from a constructivist perspective. Paper presented at the *Third European Symposium on Conceptual Change,* 26-28 June, Turku, Finland.

Pfundt, H., & Duit, R. (1994). *Students' alternative frameworks and science education.* Bibliography: Institute for Science Education at the University Kiel.

Plummer, J. D., & Krajcik, J. (2010). Building a learning progression for celestial motion: Elementary levels from an Earth-based perspective. *Journal of Research in Science Teaching,* **47**:768-787.

Posner, G., Strike, K., Hewson, P., & Gertzog, W. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. *Science Education*, **66**:211–227.

Potter, J. (1996). *Representing reality: Discourse, rhetoric and social construction.* Sage.

Prawat, R. S. (1992). Teacher's beliefs about teaching and learning: A constructivist perspective. *American Journal of Education*, **100**(3):354-395.

Pressley, M. (2006). *Reading instruction that works: The case for balanced teaching* (2nd ed.). New York: Guilford.

Pressley, M., & Afflerbach, P. (1995). *Verbal protocols of reading: The nature of constructively responsive reading.* Hillsdale NJ: Erlbaum.

Pressley, M., & Hilden, K. (2005). Towards more ambitious comprehension instruction. In E. R. Silliman & L. C. Wilkinson (Eds.), *Language and literacy learning in schools*, 151–174. New York: Guilford.

Procee, H. (2006). Reflection in education: A Kantian epistemology. *Educational Theory,* **56**(3):237-362.

Quinn, H. R. (2014). A physicist musing on teaching about energy. In R. F. Chen *et al.* (Eds.), *Teaching and Learning of Energy in K-12 Education*, 15-36.

Qureshi, A. (2007). I was being myself but being an actor too: The experience of a Black male in interracial psychotherapy. *Psychology and Psychotherapy: Theory, Research and Practice,* **80**:467-479.

Rennie, D. L. (2004). Reflexivity and person-centered counseling. *Journal of Humanistic Psychology,* **44**:182-203.

Rizaki, A., & Kokkatos, P. (2013). The use of history and philosophy of science as a core for socioconstructivist teaching approach of the concept of energy in primary education. *Science and Education,* **22**(5):1141-1165.

Roseman, J. E., Linn, M. C., & Koppal, M. (2008). Characterizing curriculum coherence. In Y. Kali, J. E. Roseman, M. C. Linn, & M. Koppal (Eds), *Designing Coherent Science Education: Implications for Curriculum, Instruction, and Policy.* New York: Teachers College Press.

Ross, K. (1993). There is no energy in food and fuels—but they do have fuel value. *School Science Review,* **75**:39-47.

Sadoski, M., & Paivio, A. (2000). Imagery and text: A dual coding theory of reading and writing. Mahwah NJ: Erlbaum.

Saglam-Arslan, A., & Kurnaz, M. A. (2009). Prospective physics teacher's level of understanding energy, power and force concepts. *Asia-Pasific Forum on Science Learning and Teaching,* **10**(1).

Saglam-Arslan, A. (2010). Cross-grade comparison of students' understanding of energy concepts. *Journal of Science Education and Technology,* **19**:303-313.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action.* New York, NY: Basic Books.

Shwartz, Y., Weizman, A., Fortus, D., Krajcik, J. S., & Reiser, B. J. (2008). The IQWST experience: Using coherence as a design principle for a middle school science curriculum. *The Elementary School Journal,* **109**(2):199-219.

Slotta, J. D., Chi, M. T. H. , & Joram, E. (1995). Assessing students' misclassifications of physics concepts: An ontological basis for conceptual change. *Cognition and Instruction,* **1**(3):373 – 400.

Smith, C., Wiser, M., Anderson, C. W., & Krajcik, J. (2006). Implications for children's learning for assessment: A proposed learning progression for matter and the atomic molecular theory. *Measurement,* **14**(1-2):1-98.

Smith, C. L., Wiser, M., & Carraher, D. W. (2010). *Using a comparative, longitudinal study with upper elementary school students to test some assumptions of a learning progression for matter.* Paper presented at the annual meeting of the National Association for Research on Science Teaching, Philadelphia, PA.

Smith, J. P., diSessa, A., & Roschelle, J. (1993). Misconceptions reconceived: A constructivist analysis of knowledge in transition. *Journal of the Learning Science*, **3**(2):115-163.

Solomon, J. (1983). Learning about energy: How pupils think two domains. *European Journal of Science Education*, **5**(1):49-59.

Solomon, J. (1985). Learning and evaluation: A study of school children's views on the social uses of energy. *Social Studies of Science*, **15**:343-371.

Songer, N. B. (2006). BioKIDS: *An animated conservation on the development of curricular activity structures for inquiry science.* In: R. Keith Sawyer (Ed.), Cambridge Handbook of the Learning Sciences, 355-369. New York: Cambridge.

Songer, N. B., & Gotwals, A. W. (2012). Guiding explanation construction by children at the entry points of learning progressions. *Journal of Research in Science Teaching*, **49**(2):141-165.

Songer, N. B., Kelcey, B., & Gotwals, A. W. (2009). How and when does complex reasoning biodiversity occur? Empirically driven development of a learning progression focused on complex reasoning about biodiversity. *Journal of Research in Science Teaching*, **46**(6):610-631.

Stephanou, A. (1999). *The measurement of conceptual understanding in physics.* Paper presented at the EARLI99, Gothenburg, Sweden.

Stevens, S. Y., Delgado C., & Krajcik, J. S. (2010). Developing a hypothetical multi-dimensional learning progression for the nature of matter. *Journal of Research in Science Teaching*, **47**(6):687-715.

Strauss, A., & Corbin, J. (1998). Basics of qualitative research: Grounded theory procedures and techniques (2nd ed.). Newbury Park, CA: Sage.

Stylianidou, F. (1997). Children's learning about energy and processes of change. *School Science Review*, **79**(286):91-97.

Subramanian, G. H., & Peslak, A. R. (2010). User perception differences in enterprise resource planning implementations. *Journal of Computer Information Systems*, **50**(3):130-138.

Sungur, S., Tekayya, C., & Geban. (2001). The contribution of conceptual change texts accompanied by concept mapping to students' understanding of the human circulatory system. *School Science and Mathematics*, **1001**:91-101.

Svedholm, A. M., Lindeman, M., & Lipsanen, J. (2010). Believing in the purpose of events: Why does it occur, and is it supernatural? *Applied Cognitive Psychology*, **24**:252-265.

Svedholm, A. M., & Lindeman, M. (2012). The separate roles of the reflective mind and involuntary inhibitory control in gatekeeping paranormal beliefs and the underlying intuitive confusions. *British Journal of Psychology*, **104**(3):303-319.

Taber, K. S. (1989). Energy – by many other names. *School Science Review*, **70**(252):57-62.

Timulak, L. (2007). Identifying core categories of client-identified impact of helpful events in psychotherapy: A qualitative meta-analysis. *Psychotherapy Research*, **17**:305-314.

Tobin, R. G., Crissman, S., Doubler, S., Gallagher, H., Goldstein, G., Lacy, S., Rogers, C. B., Schwartz, J., & Wagoner, P. (2012). Teaching teachers about energy: Lessons from an inquiry-based workshop for K-8 teachers. *Journal Science Education Technology*, **21**:631-639.

Trumper, R. (1990). Energy and a constructivist way of teaching. *Physics Education*, **25**(4):208-212.

Trumper, R. (1993) Children's energy concepts: A cross-age study. *International Journal of Science Education*, **15**:139-148.

United Nation. (2014). *Report of Sustainable Energy For All Forum*, 4 – 6 June 2014, New York.

Usher, R. (1996). A critique of the neglected epistemological assumptions of educational research. In D. Scott & R. Usher (Eds.), *Understanding Educational Research*, 9-32. New York: Routledge.

Viennot, L. (1979). Spontaneous reasoning in elementary dynamics. *European Journal of Science Education*, **1**(2):205-21.

Vosniadou, S. (1994). Capturing and modelling the process of conceptual change. *Learning and Instruction*, **4**:45–69.

Vosniadou, S. (2004). Extending the conceptual change approach to mathematics learning and teaching. *Learning and Instruction*, **14**:445-451.

Vosniadou, S., & Brewer, W. F. (1994). Mental models of the day/night cycle. *Cognitive Science*, **18**:123–183.

Warren, J. (1982). The nature of energy. *European Journal of Science Education*, **4**(3):295-297.

Warren, J. (1986). At what stage should energy be taught? *Physics Education*, **21**(3):154-156.

Watts, D. M. (1983). Some alternatives views of energy. *Physics Education*, **18**:213-217.

White, L. A. (1969). *The science of culture*. New York. Farrao, Straus, and Giroux.

White, R. T., & Mitchell, I. J. (1994). Metacognition and the quality of learning. *Studies in Science Education*, **23**:21-37.

William, E. N. & Morrow, S. L. (2009). Achieving trustworthiness in qualitative research: A pan-paradigmatic perspective. *Psychotherapy Research*, **19**(4-5):576-582.

Wilson, M., & Sloane, K. (2010). From principles to practice: An embedded assessment system. *Applied Measurement in Education*, **13**(2):181–208.

Yin., Tomita, M. K., & Shavelson, R. J. (2014). Using formal embedded formative assessments aligned with a short-term learning progression to promote conceptual change and achievement in science. *International Journal of Science Education*, **36**(4):531–552.

Yu, T. S. (1999). *Alternative frameworks of energy of form four students*. Master Thesis University Malaya.