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Patterns of Conceptual Change Process in Elementary School Students' Learning of Science

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ABSTRACT

Conceptual change requires that an individual confronts and evaluates competing concepts based on their intelligibility, plausibility and fruitfulness. The purpose of this study was to gain thorough information of conceptual change process that occurred on the elementary school students in learning science, with the focus question: How does conceptual change take place in them? Subjects of study were second, third, and fourth grade students at one of the outstanding private Elementary schools at Serang district, Banten-Indonesia. The data were collected from observations and interviews of the participants. Analysis of data resulted in the patterns of conceptual change process in learning of science occurred on these student participants. Result from the qualitative analysis data revealed four patterns of conceptual change process in student's learning of science, i.e. addition, rearrangement, replacement, and extinction. Furthermore, conceptual change process of the elementary school students in learning science may involve any of these patterns and other mechanisms. Among those patterns, rearrangement seems to be the most inclusive, while extinction is the most limited to the science learning of elementary school students. The implication of these findings is that elementary school teachers need to be aware of the importance of students' basic knowledge and to develop teaching strategies that promote effective conceptual changing process in students learning of science.

Keywords: Elementary School Students; Private Elementary School Students' Learning Of Science; Conceptual Change Process; Addition; Rearrangement; Replacement; Extinction.

INTRODUCTION

Scientific understanding is necessary for scientifically literate society. A scientifically literate society can be achieved once the students learn science by engaging in learning activities that are interesting and meaningful to them. To support students' learning, teacher must be empowered to make instructional decisions about how students learn, and how resources are allocated during instruction. Therefore, students and teachers must be partners who work together to achieve both of these learning goals.

concepts in science is frequently linked to conceptual change learning. Conceptual change in students' learning is defined as the occurrence of change in either the status of a conception or a component of the conceptual ecology (Hewson & Thorley, 1989). Student learning, according to conceptual change model, occurs when a student actively constructing and transforming their own meanings, rather than passively acquiring and accumulating

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knowledge transmitted to them (Hewson, Beeth & Thorley, 1998; Posner, Strike, Hewson & Gertzog, 1982).

Thus, student learning is not an accumulation of bits of information, but it is an interactive and connective process that is required to changes, such as addition, linkage, rearrangement, and exchange of concepts (Barlia, 2004; Beeth, 1998; Hewson, Beeth & Thorley, 1998). The process of conceptual change in students' learning of science is very crucial to understand and need more elaboration answers. The rich information of the conceptual change process in students' learning of science will be worth for teacher to develop better teaching and learning process. For that reason, this study aims to seek the patterns of the conceptual change process occur in a science class at an elementary school.

The conceptual change model in learning science describes students' learning as a complex process analogous to the way in which conceptual change is believed to occur within the scientific community (Hewson & Hewson, 1984; Posner, et al., 1982; Strike & Posner, 1985; 1992). The conceptual change model authors looked at an analogy between student's conceptual learning in the classroom and the process of conceptual change in the science community. The conceptual change model views student learning as a rational process analogous to the way in which many contemporary interpretations in history and philosophy of science picture change in the knowledge of scientific communities. Thus, scientific knowledge is constructed based on a learner current understanding of phenomenon and the impacts of new information or new ways of thinking about existing information that bear on a concept.

A concept that serves as a focus for conceptual change efforts is one with the statue of a central and organizing factor (Posner, et al., 1982). Conceptual change can have several meanings which vary depending on who are discussing the topic. However, there are some underlying themes that seem to be agreed upon in the literatures. It is mainly in the details that definitions become less consensual change is a straightforward notion. Most authors of conceptual change model would agree that it can be mean to modify, to substitute something for another, to move from one form to another, to transform, or become different. However, when the phrase "*conceptual change is used, a new dimension is added*" (Hewson, 1988, p.323). Hewson, Beeth and Thorley (1998) argued that conceptual change involves the interaction between the new knowledge and the existing knowledge in order for the new knowledge to be reconciled with the old ones. White (1993, p.4) and Chi (2008) describe conceptual change as a substantial revision of belief. For this study, conceptual change is defined as the interaction of new ideas and an individual's existing ideas followed by an evaluation of the relative power, namely intelligibility, plausibility, and fruitfulness, of the two ideas with some mental actions on the ideas.

The model of conceptual change has two components, the conditional status of a conception and the conceptual ecology. The status of a conception can be defined as intelligible, plausible, or fruitful. Each status of the terms is attached to one or more components of the conceptual ecology (Thorley, 1990). The status conception based on Hewson (1981) is the degree to which the student knows, accepts, and finds the useful idea. The conceptual ecology associates to all of the students' knowledge and recognized. Strike and Posner (1985) proposed seven components of the conceptual ecology: anomalies, analogies and metaphor, prototypical exemplars and images, metaphysical beliefs and concepts, past experience, epistemological commitments, and other knowledge.

All components of conceptual ecology may contribute to determine the status of conception. Beeth (1998) and Hewson, et al., (1998) indicated that conceptual ecology focuses attention on the interactions within this knowledge base, and identifies the roles of the interaction between these knowledge either to support some ideas and raise their status or discourage others and reduce their status. Although the components of conceptual ecology are

considered important in learning and knowledge development, student frequently do not identify components such as epistemological component or metaphysical beliefs when speaking. However, these components have been inferred from classroom discourse (Ohlsson, 2009). Other components such as analogies, metaphors, exemplars, and images are easier to recognize in literal student conversations (Chinn & Samarapungavan, 2009; Strike & Posner, 1985). All components of the conceptual ecology may contribute to determining the status of conception. If the individual experiences dissatisfaction with either the status of a conception or one of the ecological components underlying that conception, one of these four possible outcomes is likely to occur: (1) the new conception is rejected, (2) a new conception can be memorized, (3) a new conception can be captured by an existing conception, or (4) a new conception can be exchanged for a previous conception if reconciliation is not possible (Hewson, 1981, p. 386). Likewise, there are several ways in which the outcomes of conceptual change process occur, such as addition, rearrangement, replacement, or extinction (Barlia, 2004).

METHODOLOGY

This study is a descriptive case study that attempts to understand the process of conceptual change in elementary school students' learning of science with a specific research question: How does the conceptual change process in the learning of science take place on them? The study was conducted for two months during the months of September and October 2014. There were six participants who were students of grade two, three and four of an outstanding private elementary school at Serang district, Banten-Indonesia participated in this study. The grade four teacher and a parent of a grade four student also participated in this study. The selection of participants for this study is primarily based on their unique experience and different cultural background as well as their participation willingness and communication acceptances.

The data collection procedures were observations and interviews with selected student participants. Observations of teaching strategies and student's behavioral engagement in learning science resulted in information about the teaching sequence and the strategies the teacher used in her lessons. The researcher took several roles during the lessons, such as helping the teacher to set up the layout of the classrooms, asking questions to students, taking part in some student activities, and completing the day's field notes. The interview was focused on students' interpretation of the science tasks, the process learning science, and validating initial findings resulted from observation. The interview was conducted individually at least once a week in an informal condition where students were not involved in any learning activities.

Data analysis procedures included two general steps that analysis based on the researcher's intuitive reasoning from a complete reading of the data and case studies development. These two steps of data analysis took more than one cycle to produce the final case study. The first step in analyzing the data was to familiarize the general features of student engagement in learning science based on the entire data set. The final step in the data analysis procedure was to develop the case studies. Development of the case studies was specified on the patterns of conceptual change process in students' learning of science.

DISCUSSIONS OF RESEARCH FINDINGS

Teaching and Learning Process

Analyzed data gained from observation and interviews shows that teaching and learning activities in grade two, three and four of elementary school were dominated by students' presentations, hands-on experiments, problem solving, and student/teacher demonstrations. In daily classroom activities, the teachers implemented a variety of teaching

and learning approaches that promote students' conceptual understanding. The teachers frequently motivated students to think about what they already knew, why something happens, and how their ideas are related to their daily lives. Those teacher's strategies used in teaching science match to the Cimer's (2007) statement and Kucuk's (2005) finding that are relating students' existing ideas to the new concepts offered leads to teaching science effectively.

By using these strategies, the teachers expected students to physically and mentally engage in learning science for conceptual changing. One of the most crucial teaching strategies used by the teachers in that elementary school is that the teachers always facilitates classroom dialogue by giving students a chance to discuss the problems in two or more ways of communication systems. The following is the grade four teachers' view of implementing these teaching strategies is that "*students' of elementary school are social beings*". Further, the teacher explains that:

> *"Interacting with others is very crucial for students as they learn about social interrelationships, confront with different ways of seeing, different solutions to problems, and different answers to questions".*

Instruction in this class was meaningful to students as stated by a grade three student.

> "*My teacher does a very good job of taking things in science and explaining it in ways that we understand. She (the teacher) really knows how to relate to us and how to make science fun and interesting"*(Aldi).

One of grade four students explained that;

> *"Science has always been an interest of mine. I always get involved in science lesson seriously because I enjoy them and I enjoy her (the teacher) teaching style. Also she is able to discuss both what happens and why this happens and she makes you think about what you already know, and relates it to our daily life"*(Shanty).

From all of the statements above, it can be inferred that warm and supportive relationships with the teacher and ample opportunities to interact with peers are essential if the elementary school students are going to develop an understanding of science concepts offered. A good environment for students learning permits, encourages, and even necessitates interaction with others, from simple communicative interaction to the complex negotiation of conflicts.

Patterns of Conceptual Change Process

The aim of this study is to examine the meaning, reasonability, and utility of the conceptual change process based on all of the data gained from a series of observation and interview. The study results in four patterns of conceptual change process that might occur on student' learning in science namely addition, rearrangement, replacement, and extinction. Addition can be defined as a creation of new concepts held without a significant change in the status of pre-existing concepts in a conceptual framework; rearrangement, reorganization or structural change within a system of interrelated concepts; replacement, the exchange or substitution of one concept for another; and extinction, the loss or disappearance of a concept (Barlia, 2004; Beeth, 1998; Hewson et al., 1998). Examples and the intelligibility, plausibility, and fruitfulness of the conceptual change possibilities are discussed in the following section.

1. Addition

Addition is adding information to knowledge rather than trying to rearrange, replace, or delete previous concepts and it occurs from the scratch. An important consideration is to determine and acknowledge what the students bring to the classroom, so that a teacher can

help them to add ideas to their own conceptual frameworks in a useful fashion. Ebenezer and Gaskell (1995) stated that conceptual change for teachers and students is not just viewed as a replacement of old concepts, but also a process of learning to relate new ideas to appropriate contexts. The Ebenezer and Gaskell's (1995) study was focused on students' understanding of solubility and solutions. The students were asked to talk about and explain their views before starting the series of lessons. These talks included six distinct categories involved in the topic. After the lessons, there were two additional categories added to the student's existing knowledge. If the teacher had planned to influence learners to replace some knowledge or make it extinct, if that were even possible, it would have required a great deal of time. The following stories told by students' learning in science observed were very interesting to analyze as part of addition process in conceptual change learning in science:

In the second grade classroom, a disk was sat on a table. Dea, who is eight years old, sat down on the table and rocked the disk side to side, her eyes followed the movement of the marbles. After a few minutes, she carefully tipped the disk and rolled all the marbles towards her. She then experimented by tipping the disk to make the marbles move directly away from her. Next, Dea slowly tipped the disk, causing the marbles to roll in a circular motion around the disk. She stopped every now and then to reverse the direction of the motion.

As envision of the third grade students of the elementary school selected for this study in which several students were constructing a house made of cardboard box. They were trying to attach fronds of palm leaves and are faced with many problems in doing this, in constructing an archway across the front, and in covering the roof portion. These students had an idea to make their own house after reading a book about *Anak Dalam* tribe in Sumatra. The reading of this book and the students' idea of building a house resulted in rich activities that are integrating cultural studies, math, science, and literacy in the context of rich cooperative group interaction. They had to measure and estimated the lengths, weight, balance, and the properties of inclination of the various materials they used to construct the house.

From the two stories of students' learning activities above, it can be inferred that old theories about making the marbles move and building house in their tribes are not necessarily discarded in favor of new ones for the simple reason that the old theories remain useful in interpreting certain situations (Carey, 2011; Ebenezer & Gaskell, 1995). It is reasonable to acknowledge that students may find their original conceptions effective for interpreting conceptual structures that are new to them and use the familiar concepts as a foundation for adding new ideas. Given that ideas are held in contexts, the process of change may not be one of replacements of an idea but rather the distinguishing between contexts (Linder, 1993). Thus, a student may add new information into an appropriate context or conceptual hierarchy and use it for deeper understanding of the particular content.

Teachers always struggle with learning processes by making choices about viable ways for each student to learn concepts and how to present the material in a concise manner. To infer addition as one of possibilities patterns for some conceptual change helps us to believe that students may add to their existing knowledge. A good example to explain the process of accommodating the addition of new concepts to a pre-existing conceptual framework is the way a carpenter build a new house or make an addition to a pre-existing house. A good carpenter does not tear down his previous day's work, but extends it to a new level of accomplishment. A learner needs not necessarily to abandon or radically rearrange specific notions, but may add to them as a carpenter builds or as one might add information to a file.

Addition might be one of the ways for conceptual change. Thinking about teaching in terms of addition should help a teacher consider students' prior knowledge and understanding (Barlia & Beeth, 1999; Barlia, 2014). The implication of this finding is that in the teaching learning process, the teachers' understanding and acceptance of students' thoughts are the

crucial part in promoting effective students' learning. The teacher then has a starting point to help the students learn more effectively by introducing concepts and ideas for the students to use in building more complex conceptual structures.

2. Rearrangement

Rearrangement, restructuring, or reorganization is one of the changing processes that will be discussed in this section. This section includes some examples which illustrate the idea of conceptual change as restructuring and discusses some of the literature which either supports or questions of this pattern of conceptual changing.

The following is the statement from one of the participants' parent who has just come from studying abroad. He studied at one of the state universities in United Stated of America for several years. His family was brought along during his study. Right now his son is sitting on the fourth grade. He told an experience about possibility of conceptual change process on his son:

> *"I have a son, at that time he was not quite five years old, who looked out a window at a winter snow storm and exclaimed, "Look, it's raining snow!" My son acquired the concept and term of rain and raining during the rain and dry seasons which originally knows in our home country before. For him, the term precipitation is unlikely to be intelligible, and any form of precipitation appears to be considered a form of "rain". As he grows older, he has more sensory experiences involving weather and grows in different linguistic ability (American English). By next winter, he was looking out on a winter snow; he is likely to exclaim, "Look, it's snowing!"*(A fourth grade student's parent).

From the statement above, it can be inferred that it is an example of conceptual reorganization, rearrangement or restructuring, since the concepts of rain and raining are not replaced by the concepts of snow or snowing. The child may reorder his knowledge and understanding of weather phenomena and language to accommodate the distinction between raining and snowing.

To better understand of how students restructure conceptual frameworks using new knowledge, it is important to review some theories which suggest how the conceptual reorganization, rearrangement or restructuring occurs. One way that cognitive science examines learning process is by studying the novice-expert shift in adults and how individuals restructure knowledge when they accumulate new facts. Some authors believe that conceptual change is knowledge restructuring (Carey, 1987; Hewson, et al., 1998), according to their view all knowledge has some structures. In one point of view, restructuring refers to the idea that adults (experts) consider or hold various concepts and the relationships among concepts differently than elementary school students (novices) hold a similar, or less complex concepts. Moreover, these relations allow the experts to create new abstract concepts and schemata which may not be accessible to novices. Adults (experts) manipulate their knowledge in a way to help them to deal with the underlying structure of the problems, otherwise elementary school students (novices) apparently do not, since they approach cognitive problems directly and naively. Carey (1987) views restructuring primarily as implicating a basic level-subordinate level shift. What a novice takes as a basic or fundamental concept may often be considered a subordinate level concept to an expert. A logical implication is that as in novices apprehend new concept, they may arrange the connections and position or status of interrelated concepts (Clement & Zeitsman, 1989). It may be that restructuring at conceptual frameworks through increasing their complexity is the way a novice becomes an expert.

Earlier theories of cognitive development framed by Vygotsky, Piaget, and Bruner suggested a general shift in the organization of conceptual structure at specific point in a child's development. For example, Bruner and Piaget mentioned the shifts from concrete to abstract. They assumed that conceptual change as restructuring focuses on a shift from

categories based on a large number of similar features or spontaneous concepts to categories based on one or two principal features or dimensions---scientific concepts (Bloom, 1992). In other words, as concepts are better understood the distinctions between related concepts may become more fines. It appears that novices are conceptual lumpers while experts are conceptual splitters.

According to Carey (1987), there are two different senses of restructuring. In the weaker sense of restructuring new relationships among concepts are found which change the solutions to old problems without changing the core concepts of a conceptual framework or conceptual ecology. This weak restructuring happens, for instance, as a player gains expertise in chess. Novices and experts share the core concepts of chess. The rules of movement, approximate value of pieces, the objectives of the game are held in common. Experts acquire more subtle and complex concepts dealing with position and strategy that novices lack and so perceive the game with more finesse and subtlety than novices.

In the stronger sense of conceptual change, the same changing process occurs but accompanied by a change in the personal core concepts of successive conceptual systems of an individual (Ohlsson, 2009). Restructuring in the strong sense implies that the novices neither represent conceptual relationships in the same way as experts, nor specific core concepts or schemata available which experts may have at their disposal. The idea that reorganization, rearrangement, or restructuring of a conceptual system can and does occur in many instances is comprehensible, plausible, and at least to this group, fruitful (Hewson & Hewson, 1984). As the concepts are encountered they must be accommodated, assimilated or rejected. Assimilation implies integrating concepts into existing conceptual system which might reasonably entail a change in relationships among concepts and thus rearrangement. Accommodation implies adjusting an existing conceptual system to a new concept, which also implies rearrangement of some kind. Even rejection of a concept might cause some change in the relationships among concepts which could be called reorganization, rearrangement, or restructuring.

3. Replacement

To establish the plausibility and utility is the essential idea of replacement or exchange as one of the process for conceptual changes. Is it reasonable to believe that a concept can be replaced by another in an individual's conceptual framework? If the answer is yes, it does not necessary exclude the existence or use of other means for conceptual change. Within the scientific community, the concept of spontaneous generation is no longer accepted. The geocentric model of solar system is also no longer accepted. Each of these ideas failed to meet the demands of credibility and usefulness. Each concept was replaced by another which was more plausible and fruitful. Each concept was replaced because it was not compatible with new evidence. They no longer fit in the conceptual networks of which they had been a part. They were replaced, first within the scientific community and then a larger community, by concepts that provide a more accurate or acceptable representation of natural processes from the available data.

The concept of "spontaneous generation" was replaced by the idea that all living cells come from other living cells and by extension, that living organisms reproduce similar living organisms. The geocentric model of solar system was replaced by the more elegant and practical heliocentric model. The examples illustrate replacement as conceptual change at a social or community level. However, conceptual change begins with individual people. Each individual develops and organizes a personal conceptual ecology or a body of interrelated concepts. Rational individuals seek coherence and economy of concepts. When a learner is confronted with a conflict between a familiar concept and a new concept of equal or greater explanatory power, he or she must assimilate or accommodate the new concept (Rusanen &

Poyhonen, 2012; Strike & Posner, 1985, 1992). The individual must evaluate the competing ideas and somehow reconcile them, reject the new concept, or replace the old concept with the new one.

The process of accommodation involves the individual's evaluation of the competing concepts in three areas: intelligibility that is the concept must make sense to the individual, plausibility that is the concept must be credible and reasonable for the individual, and fruitfulness that is the concept must have practical value for the individual. Once the concepts are irreconcilable with regard to one or more of these basic levels, conceptual exchange might occur (Beeth, 1998; Hewson, 1981; diSessa, 2008). This indicates that the individual can no longer make sense of a situation or event with the old concept. It is no longer seems to fit. When a concept is no longer fit an individual's conceptual ecology, it may be replaced by a competing concept which is more intelligible, plausible or fruitful.

For the last four weeks, Dani and Nita, the fourth grader students have been taking walks to the small grove of trees adjacent to the schoolyard. Each student has selected a tree to be "his" or "her" tree and they have familiarized themselves with the trees, using both words and pictures. Today the teacher brought a video camera. Each child had the opportunity to direct the teacher to different parts of the tree he or she wanted to videotape. Upon returning to the classroom, the teacher played the videotape and the students guessed which tree was theirs. Dani was sure that the first was "his". "*See*", he directed the students. *"Look at the bottom of the trunk, there is a scar line on my tree!"*. The teacher stopped the tape while they examined it more closely. Nita argued, "My *tree has a line too, and look, the leaves are missing from one branch. It must be my tree*". The students continued to examine the tape, sharing the attributes of their trees and deciding which tree "*belongs*" to whom.

In the second grade classroom, various "*reconstruction*" materials were placed on the shelf. In one area of the room, Suti sat down on the floor and reached for the toy car hinged, interlocking parts. She called to Bambang, "*hey, let's make transformers*". Both students immediately began putting pieces together. Suti put together various pieces, swiveled the hinged parts around, and said, "*My car is changing into helicopter*". Bambang looked closely at what she has put together, looked at his "*Airplane*", and took it apart carefully, "*I'm making a 'copter transformer too*", he announced and started to duplicate Suti's construction.

From those two descriptions of students' learning activities it can be inferred that the idea of exchanging or replacing one concept with another which has greater power is both reasonable and intuitively attractive. As the students have new experiences, they frequently find themselves confronting discrepancies and errors in their understanding of many objects and phenomena. If the discrepancy or error is great enough, old ideas or concepts may be set aside and replaced by new concepts deemed by the individual to be more intelligible, plausible, and fruitful. The implication of all described above is that elementary school teachers have to be aware of students' conceptual condition if they want to be successful in facilitating students learning process for conceptual changing.

4. Extinction

The term 'extinction' was not found in the conceptual change literatures. However, borrowing from psychology, extinction refers to the tendency of a response to disappear if it is not reinforced (Engler, 1979; Rusanen & Poyhonen, 2012). Pavlov's classical conditioning experiments showed the necessity to provide reinforcement to elicit a particular response. Failure to provide reinforcement leads to the disappearance or 'extinction' of a learned behavior. To use the term extinction within the framework of conceptual change, one assumption is that a new concept must be or may be reinforced over time before a student could find it intelligible, plausible, and fruitful. Although possible, intelligibility, plausibility, and fruitfulness would not necessarily occur simultaneously and requires time for a student to

grasp a new concept (Hewson & Hewson, 1984; White, 1993), thus internalizing it as part of their conceptual ecology is an important stage of students' learning. If the student fails to find the new concept intelligible, plausible, or fruitful, and does not utilize it and thus does not reinforce it, then it would be discarded or become extinct and is no longer a part of the conceptual framework.

In order to strengthening the idea of extinction as one of the possibilities in the conceptual change process of students' learning in science, a fourth grade teacher in this study asked her students about their opinion and conception of the rainbow. One of the fourth grade students (Sisca) explained her experience and conception about rainbow:

> *"When I was a little girl a get the story about a rainbow, the myth said that when rainbow come in the sky, there are seven angels taking bath in the pond, lake, or in the river dam. In that time, each time I saw a rainbow I was so curious to find the bathing angels in the ponds, lakes or in the river dams. But, up to now I never find it, and I never proof it. Last week my teacher demonstrated the formation of a rainbow. I realized that rainbow is the separation process of sunlight by the rain. So, right now, I will not believe that the rainbow is because the angels are taking bath in the river dams, ponds, or lakes".*

The statement can be inferred that the student's old conception about rainbow was replaced or might be punished even only for a while. The student conception about the occurrence of rainbow because of seven angels taking bath in the ponds, lakes, or river dams was replaced by the new conception. Student's believed that the occurrence of rainbow because of separating process of sunlight by the water poured or rain. Thus, the indication that replacement because of the prior knowledge was punished in the conceptual change process of students' learning science is crucial to be considered.

If a new concept replaces an antiquated concept or is accommodated as part of a new conceptual ecology, then the old concept due to lack of reinforcement becomes extinct. However, Bloom (1992) suggests that this is not a case. He states that one cultural context or intentional world is not replaced by another allegiance can change, but the previous context or conception does not disappear. Driver (1987) said that learning is an adaptive process in which conceptual schemes are progressively reconstructed. Carey (1987) stated that cognitive development consists, in part and in the emergence, of new theories out of these older ones, with the concomitant restructuring of important concepts and emergence of new explanatory notions. A new concept may become extinct if it is understood but not incorporated into an individual's conceptual ecology or framework. Therefore, extinction of an old concept would be less likely according to Bloom, Driver, and Carey.

To become extinct, a concept must lose its intelligibility, plausibility, or fruitfulness. In most cases of concept rejection or extinction, there is a concept available to replace the old concept, but sometimes there is no viable alternative, only an acknowledgment that the concept is no longer worth holding. Pintrich, Marx, and Boyle (1993) equate conceptual change to historical changes in scientific theories. They maintain that a theory is only replaced by a better theory and is not discarded unless the contradictory evidence is explained by this new and better theory. The better theory may be accepted without a confrontation of the old knowledge. One author has personally observed where students had a concept that was incorrect. In this science class, two-thirds of the students had the wrong idea about a control step that was part of specific procedure. The teacher decided to have students design an experiment that showed what would happen if the procedure was not followed.

After the experiment, students had to let go of their preconceived assumptions in the face of observing unexpected or a new data. In this example, the students had an alternative concept available to replace their original concept that evidence showed to lack fruitfulness and plausibility. In this instance had an alternate explanation not been available, the students might not have relinquished their original erroneous conception. Extinction does not seem to

play a significant role in conceptual change. Behaviors may become extinct but concepts seem more likely to be modified or replaced rather than rejected outright or left to wither. Concepts achieve status in a conceptual ecology or framework because of their fruitfulness, intelligibility, and plausibility. Extinction implies not only a lack of these three traits, but a lack of an alternative concept with sufficient power to fill the niche left unoccupied by the extinct concept. Logically, conceptual extinction may only be a part of conceptual replacement or exchange and not an end in itself.

CONCLUSION

The conclusion drawn from this study is that each of the patterns for conceptual change namely addition, rearrangement/restructuring/reorganization, replacement or extinction, has some merit and explanatory power. It would be simplistic and reasonable to believe that conceptual change only happens one particular way. Since conceptual change occurs in the minds of individuals before being socially negotiated, there may be other means of conceptual change as well as the four described before.

Conceptual rearrangement or restructuring may subsume addition and replacement. It could also include conceptual extinction, if conceptual extinction does take place. For conceptual change to take place an individual must recognize that two or more analogous and competing concepts exist. If one concept is found to be more intelligible, plausible and fruitful than the other, then that concept is more likely to be retained and the less intelligible, plausible or fruitful concept abandoned. If a new concept is retained and a previously held concept abandoned the process may be considered replacement. If an existing concept is reconcilable with a new and analogous concept then the new concept may become part of a conceptual ecology through addition or rearrangement. Addition considered as a form of rearrangement in the sense that a new niche is created in a conceptual ecology when a new concept is added.

The pattern of changing, extinction is problematic where the extinction might be considered an aspect of replacement. There is abundant evidence that elementary school students, do not give up existing concepts easily. Even when a new concept appears to have replaced a previously held naïve or alternate conception the “old” concept often remains, although in a position of lower status in the conceptual ecology. Could this be analogous to the way that old clothes which no longer fit may be put away in storage for some indefinite period of time? The clothes are not used but can be accounted for and are held against future use. Might replaced concepts be held in a similar manner? If so, then conceptual replacement may also be visualized as a form of conceptual rearrangement. In summary, each of the conceptual change patterns, i.e., addition, restructuring, replacement, and extinction that might be occurred in elementary school students is feasible as means of conceptual change.

Restructuring or rearrangement is the most inclusive and fruitful of the four patterns offered above since it can include addition and replacement. Extinction is the weakest pattern since it seems less plausible than the other three. The implication of the findings is that the elementary school teachers’ knowledge of the patterns of the science concept changing process is required in designing elementary school students’ learning process of science effectively. Elementary school teachers need to be aware of the importance of students’ basic knowledge for the effective conceptual change process in teaching and learning science. In addition, teachers need to develop teaching strategies that promote better students learning in science for conceptual changing.

REFERENCES

Barlia, L. (2014). Elementary school students' motivation profiles in learning science for conceptual changing. *International Journal of Science and Research,* 3(7), 428-438.

Barlia, L. (2004). Empat metode perubahan konseptual hasil belajar. *Pedagogia,* 2(1), 57-71

Barlia, L. & Beeth, M.E. (1999). *High school student's motivation to engage in conceptual change learning in science*. Paper presented at the annual meeting of the national association for research in science teaching, Boston, MA, USA.

Beeth, M.E. (1998). Facilitating conceptual change learning: The need for teachers to support metacognition, *Journal of Science Teacher Education,* 9(1), 49-61.

Bloom, J.W. (1992). *Conceptual change or contextual flexibility: The myth of restructuring and replacing conception*. Paper presented at the annual meeting of the American education research association, San Francisco, CA.

Carey, S. (1987). Introduction. In S. Carey [Ed], *Conceptual change in childhood* (1st ed). Cambridge, MA: MIT Press, 1-14

Carey, S. (2011). Precis of the origin of concepts. *Behavioral and Brain Sciences,* 34, 113-167

Chi, M.T.H. (2008). Three types of conceptual change: Belief revision, mental model transformation, and categorical shift. In S. Vosniadou (Ed.), *Handbook of Research on Conceptual Change* (pp.61-82). Hillsdale, NJ: Erlbaum.

Chinn, C.A., & Samarapungavan, A. (2009). Conceptual change – multiple routes, multiple mechanisms: A commentary on Ohlsson. *Education Psychologist,* 44(1), 48-57

Cimer, A. (2007). Effective teaching in science: A review of literature. *Journal of Turkish Science Education*, 4(1), 20-44

Clement, J. B. & Zietsman, A. (1989). Not all preconceptions are misconceptions: Finding 'anchoring conceptions' for grounding instruction on students' intuitions. *International Journal of Science Education,* 11(5), 554-565

diSessa, A.A. (2008). A bird's eye view of the "pieces" vs. "coherence" controversy (from the "fieces" side of the fence). In S. Vosniadou (Ed.), *International Handbook of Research on Conceptual Change* (pp. 35-60). New York: Routledge

Driver, R. (1987). *Changing conceptions*. Paper prepared at the International Seminar, Adolescent Development and School Science, King's College, London

Ebenezer, J. & Gaskell, P. J. (1995). Relational conceptual change in solution chemistry. *Science Education*, 1-17

Engler, B. (1979). *Personality theories: An introduction*. Boston: Houghton Mifflin Co.

Hewson, M.G.A'B. (1988). The ecological context of knowledge: Implications for learning science in developing countries. *Journal of Curriculum Studies,* 20(4), 317-326.

Hewson, P.W. (1981). A conceptual change approach to learning science. *European Journal of Science Education,* 3(4), 383-96

Hewson, P.W., Beeth, M.E. & Thorley, N.R. (1998). Conceptual change teaching. In B.J. Fraser and K.G. Tobin (Eds.), *International Handbook of Science Education*. Dordrecht, The Netherlands: Kluwer Academic Publisher.

Hewson, P.W. & Hewson, M.G.A.B. (1984). The role of conceptual conflict in conceptual change and design of instruction. *Instructional Science,* 13(1), 1-13

Hewson, P.W. & Thorley, N.R. (1989). The condition of conceptual change in the classroom. *International Journal of Science Education,* 11(5), 541-553

Kucuk, M. (2005). Examination of different learning levels of students' and student science teachers' concepts about gravity. *Journal of Turkish Science Education*, 2(1), 23-28

Linder, C.J. (1993). A challenge to conceptual change. *Science Education,* 77(3), 293 –300

Ohlsson, S. (2009). Resubsumption: A possible mechanism for conceptual change and belief revision. *Educational Psychologist,* 44(1), 20-40

Pintrich, P.R., Marx, R.W. & Boyle, R.A. (1993). Beyond cold conceptual change: The role of motivational belief and classroom contextual factors in the process of conceptual change. *Review of Educational Research,* 63(2), 167-199

Posner, G.J., Strike, K.A., Hewson, P.W. & Gertzog, W.A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. *Science Education,* 66(4), 211-227

Rusanen, A-M. & Poyhonen, S. (2012). Concepts in change. *Science & Education,* 2012 (on line first), DOI: 10.1007/s11191-012-9489-x.

Strike, K.A. & Posner, G.J. (1985). A conceptual change view of learning and understanding. In L.H.T. West & A.L. Pines (Eds.), *Cognitive Structure and Conceptual Change*. Orlando, Florida: Academic Press.

Strike, K.A. & Posner, G.J. (1992). A revisionist theory of conceptual change. In R.A Duschl & R.J. Hamilton (Eds.), *Philosophy of Science Cognitive Psychology, and Educational Theory and Practice*. Albany, N.Y: State University of New York Press.

Thorley, N.R. (1990). *The role of the conceptual change model in the interpretation classroom interactions*. Unpublished doctoral theses, University of Wisconsin-Madison

White, R.T. (1993). *Insights on conceptual change derived from extensive attempts to promote metacognition*. Paper presented at the meeting of the American Education Research Association, Atlanta, GA.