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Abstract

The primary purpose of science education is to help students become scientifically literate. In this study, what misconception is and why misconception occurs and how Learning Cycle approach can overcome misconception in science will be explained in the light of research. Students who enter the classroom with inappropriate pre-existing ideas about the world, which are not to scientific explanations, are said to have misconceptions. The results from a review of literature show that misconceptions occur for many reasons. These reasons of misconceptions are mismatch between science concept and student's mental functioning levels (Piaget`s model), cognitive achievement and IQ status of students, absenteeism of students, and informal learning. Correcting misconceptions requires learners to be both aware of the misconception and dissatisfied with it and a replacement concept to be available intelligible, plausible, and applicable. Learning cycle identifies misconceptions at early stages of learning; and teachers may easily stop teaching way and then redirect concept. Basically learning cycle teaching approach prevent misconceptions in three ways; concept understanding, improved problem solving, better laboratory skills, and also technological tools help to eliminate misconceptions.

***Keywords**: Misconception, Learning Cycle approach, Science Education*

ÖĞRENME DÖNGÜSÜ YAKLAŞIMININ FENDEKİ KAVRAM YANILGILARININ GİDERİLMESİNDEKİ ROLÜ

Özet

Fen bilgisi eğitiminin temel amacı öğrencilerin bilim okur yazarı olmalarına yardımcı olmaktır. Bu çalısmada kavram yanılgılarının tanımı ve nasıl ortaya çıktıgı, bu konuda "Ögrenme Döngüsü" yaklaşımı ile kavram yanılgılarının üstesinden nasıl gelindiği yapılan bilimsel araştırmalar ışığında açıklanmıstır. Sınıfa gelen öğrencilerin dünya hakındaki bilimsel olmayan fikirlere sahip olmaları onların kavram yanılgısına sahip oldukları söylenir. Literatür incelenmesi kavram yanılgılarının bir çok nedenden dolayı ortaya çıktıgını göstermistir. Kavram yanılgılarına neden olan etkenler fen kavramının öğrencinin Piaget'nin zihinsel gelişim modeli dönemleri ile olan uyumsuzlugu, ögrencinin bilişsel gelişim evresi ve zeka (IQ) seviyesi, ögrencinin derse devamsızlığı ve okul dışı ögrenimleridir. Kavram yanılgısını düzeltmek için öğrencilerin kavram yanılgılarından haberdar olması ve bundan rahatsızlık duyması ayrıca kavram yanılgısını ortadan kaldıracak doğru kavram bilgisinin anlaşılabilir, mantıklı ve uygulanabilir olmasına ihtiyaç vardır. Temel olarak "Ögrenme Döngüsü" yaklaşımı kavram yanılgılarına, kavramı anlama, problem çözme ve laboratuvar becerileri olmak üzere üç yönüyle müdahale eder. Ayrıca teknolojik araç gereçler de kavram yanılgılarını ortadan kaldırmada yardımcı olurlar. Sonuç olarak Ögrenme Döngüsü yaklasımı ile kavram yanılgılarını ortadan kaldırmada diğer yöntemlerden daha başarılı sonuçlar alınmıştır, çünkü "Ögrenme Döngüsü" yaklaşımı, yapılandırmacı (constructivist) yakalaşımı baz alan ve bir sorgulayıcı (inquiry) öğrenme yöntemi olduğundan başarılı sonuçlar elde edilmiştir.

***Anahtar Sözcükler**: Kavram yanılgıları, Öğrenme Döngüsü yaklaşımı, Fen Bilgisi Eğitimi*

Introduction

The primary purpose of science education is to help students become scientifically literate. In traditional (expository) science classrooms, content and inquiry skills are taught separately. In these classrooms, content is taught didactically through lecture, reading, and problem solving exercises and scientific practices are taught through structured laboratory experiments. On the other hand, inquiry method interconnected content knowledge and inquiry skills through activities that incorporate authentic scientific inquiry (Abraham, 1998; Renner & Stafford, 1972). Students have misconceptions in every level of school. The results from a review of literature showed that misconceptions occur for many reasons, from misunderstanding of vocabulary to combining several ideas into one. The problem is, as a teacher, how we overcome misconceptions. One method of teaching science that has gained considerable ground in the past three decades is the use of inquiry based Learning Cycle approach to make science a more hands on and minds on endeavor. Although Learning Cycle approach has been around since the early 1900's (Marek & Cavallo, 1997), implementing Learning Cycle approach into the classroom has proven to be a challenging task for teachers at all levels.

The purpose of this study is to show how Learning Cycle approach can overcome students' misconceptions about science in the light of literature. First of all, we will describe what misconception is; next, introduce what Learning Cycle approach is; and finally show the applications of Learning Cycle approach to overcoming misconceptions.

What Misconception is

American Heritage Dictionary described (2000) that a misconception is an idea about or an explanation for a phenomenon that is not accurately supported by accepted physical principles; a mistaken thought, idea, or notion; a misunderstanding. Misconception is generally defined as something a person knows and believes but does not match what is known to be scientifically correct. Often times, students come to class with already formed ideas about range of scientific phenomena that are not accurate. Students who enter the classroom with inappropriate pre-existing ideas about the world, which are not to scientific explanations, are said to have *misconceptions*.

Identification of Reasons for Misconception

Many studies indicate that student misconceptions about thing, which have a scientific dimension or explanation, are extremely common. A large body of literature has examined misconceptions in the biological and physical sciences, and has showed that science concept understanding is related to the students' cognitive development level.

One of the biggest reasons for misconceptions is mismatch between science concept and students' cognitive development levels. There are many studies on this subject. Summary of many studies is that students in the concrete operational level of Piaget cognitive stages could not understand the formal concepts of science until entering the formal stage, therefore, many students could not benefit from such science curricula and misconceptions occurs (Abraham, Williamson & Westbrook, 1994; Baser, 2006; Koray, Özdemir & Tatar, 2005; Lawson & Renner, 1975; Marek, 1981; Marek & Renner, 1972-1979; Posner, Strike & Hewson, 1982; Renner 1985; Shepherd & Renner, 1982), because concrete concepts can be understood only through experiences, that is, concrete

learners understand only concrete concepts. For example, Marek and Renner (1972) stated that according to the science education center at the University of Oklahoma indicated that 73 percent of the 10th grade students interviewed cannot do formal operational thinking in the Oklahoma's secondary school students. Over 70% of the 8th-grade (Simpson & Marek, 1988; Marek & Bryant, 1991), and over 50% of 10th-grade students (Simpson & Marek, 1988; Marek, 1986) had misconceptions about biology. In the cross-ages studies showed better evidence, such as Westbrook and Marek (1991) found that over 60% of 10th-grade and college students, 55% of 7th-grade students had misconception about diffusion topic. In 1992 these two colleagues found similar results on understanding of the concept of homeostasis. 46% of 7th-grade, 54% of 10th-grade, 64%of college students had misconception. The reason of these misconceptions is that students are not able to understand abstract knowledge.

Another reason of misconception is cognitive achievement and IQ status of students. Marek (1981) found that there was a correlation between cognitive development and content achievement, cognitive development and inquiry skills achievement, and cognitive development and IQ.

Additionally, a gender issue is very important area of analyzing misconception. Marek (1981) stated that level of logical thinking is higher in men than women. In 1984, Marek did a new research with friends to investigate the relationship between gender and intellectual development for senior high school students. It was found that the gender and age variables operated independently in terms of their relationship to performance on the formal task and there are gender differences among high school students in the ability to do proportional reasoning, which is the ability to compare ratios or the ability to make statements of equality between ratios. Piaget considered the ability to reason proportionally to be a primary indicator of formal operational thought, and this stage is viewed as the highest level of cognitive development. This is very important to learn science because, in high school, the concepts are generally related to biology, physics, and chemistry and each of them uses proportional reasoning. So science teachers need to be aware of this fact (Hernandez, Marek & Renner, 1984).

Students learn their own concept from their experiences and this way of learning keep knowledge longer in students' minds than other learning ways (Marek & Methven, 1991). Only using textbook may be the reason of misconception because if students preexisting schemata is not related to textbook knowledge, that pushes students in misconceptions hole (Renner, Abraham, Grzybowski & Marek, 1990; 1992). Therefore teachers have to be aware of when selecting activities that allow the students to solve problems and to construct concepts directly from their experiences.

In 1969, Easley stated that teachers had to find out what students think about phenomena before deciding on the particular experiences and theory to present in their science classes, and analysis of students preexisting knowledge provides useful data about students' understanding of science concepts (Marek, 1986). One of the reasons is that even preexisting knowledge affects misunderstanding of science concept because new concept could not match with old concept; therefore, theoretical knowledge and preexisting knowledge are significantly different in student mind (Haidar & Abraham, 1991). If we do conceptualization research or individual interview techniques, at least we can get some clue about what our students have in their minds.

One of the reasons of misconceptions is absenteeism of students. This is logical reason to see why students who missed the class have misconceptions. Marek, Askey, and Abraham (2000) stated that if the students missed on phase of learning cycle, even they took make-up lesson for missing phase of learning cycle, there is an obstacle for students in understanding learning concept.

Another reason for misconceptions is informal learning, which takes place outside the formal classroom. Generally many students do spend 17 hours out of school in one day and during this time students sleep, eat, watch TV, play electronic games, read, spend with their friends and their family, practice in sports and so on. So students also learn out of school time. According to Piaget (1964), three factors; direct experience, cognitive conflict, and social interactions help learners to construct their own knowledge through formal learning experiences and informal learning experiences. In addition, social constructivist Vygotsky stated that social interaction was the way that students' built new knowledge. Such science education research identified informal learning experiences as potentially influential (Gerber, Marek & Cavallo, 2001a; 2001b).

Although there are not many studies showing the relationship between environment and misconception, Simpson and Marek (1988) stated that students attending large high schools had more understanding and less misunderstanding of four biology concepts, homeostasis and diffusion than students attending small high school. The reason may be that diffusion and homeostasis concepts are in formal operational level, maybe higher percentage of students are formal operational level in large school. Of course, many reasons affect the Simpson and Marek (1988) research results such as absenteeism, hungry, weather and so on. On the other hand, there was not found any significant difference on food chain and classification concepts between large and small schools.

Applying Learning Cycle Approach to Overcome Misconceptions

The learning cycle consists of the three phases, "exploration," "term introduction," and "concept application." In exploration phase students gather and record data. It is related to assimilation and disequilibrium, because, when information is received from the outside world, which is too far away from the mental structure, students does not make enough sense that rejecting in their mind, and students should be in a state of disequilibrium, or if the information fits the external reality to their existing cognitive structure, they can easily assimilate in their mind. That is students are in the equilibrium phage (Abraham, 1998; Fleener & Marek, 1992; Lawson, 2001; Lawson, Abraham & Renner, 1989; Marek & Cavallo, 1997; Türkmen, 2006). The exploration phase has the students interact with the laboratory environment while collecting data formally or informally. According to Marek, Eubanks, and Gallaher (1990, p. 832) point out that "students… have experienced or assimilated the essence of the concept. The experience is more directed than in the pure discovery approach, but care is taken not to tell the student what data is neither to be used in developing the desired concept nor to ask the student to interpret data prematurely." Students are compelled to confront any misconceptions that they may have formed as a result of prior experience or instruction in this phase.

Term introduction phase of the learning cycle is when students are expected to accommodate the new ideas. The teacher takes an active role in presenting the concept. Students redefine, change, or invent mental structures at this point. Students will be in the accommodation phase in this learning cycle stage, because students make their own meaning out of the observations. Either they succeed to make adjustments in each mental structure to make it fit their experience, or they do not construct the new mental structure and then fall in the disequilibrium phase again.

In the concept application stage, children continue to expand the concept by conducting more activities and using additional resources for investigation. The expansion of the idea may involve "additional laboratory experiences, demonstrations, readings, questions, and/or problem sets" (Marek, Eubanks & Gallaher, 1990, p. 831). Concept application matches to the organization phase in the Piaget's mental functioning. The concept application stage's intent is to aid the organization and generalization of knowledge by adjustment of related mental structures and transfer from one context to another.

Misconceptions are not easily replaced. Correcting misconceptions requires that learners be both aware of the misconception and dissatisfied with it and that a replacement concept be available that is intelligible, plausible, and applicable. Although students are revealed to scientifically accurate mental models in a science classroom, many students tend to finish their science courses with the same misconceptions with which they began. In fact, students who take more science classes and earn higher grades might have more misconceptions than do less academically prepared students with less science background (Marek & Bryant, 1991). Because many teachers teach from the traditional perspective, viewing knowledge as being transmitted by the expert teacher to a passive learner, who comes to class without any preformed concepts, with the goal that students remember and reproduce the knowledge given upon them. Traditional approach leads to shallow understanding because of its emphasis on memorization and recitation of facts (Ayas, 2002; Ayas & Özmen, 2002; Aydoğan, Güneş & Gülçiçek, 2003; Gülçiçek & Yağbasan, 2004; Saka & Akdeniz, 2006; Uzuntiryaki, 2003; Yıldırım, Nakiboğlu & Sinan, 2004). Whitehead (1929) pointed out 75 years ago, the focus on memorization leads to "inert knowledge" that cannot be called upon when it is useful.

However, Learning Cycle approach is an inquiry-based learning and its "goal is to enhance learning and provide students with more authentic science experience that imitate those real scientists and are in accordance with the nature of science" (Türkmen, 2006, p.73) and its role is to overcome the inert knowledge problem by describing how learning activities can foster useful conceptual understanding that will be available to the learner when it is relevant and learning cycle is a way of translating the inquiry process used by scientists to advance students' understanding into a process (Renner & Stafford, 1972). Marek, Cowan, and Cavallo, (1994) showed that 94% high school biology students understood the concept of diffusion in learning cycle classroom but 58% students understood diffusion concept traditional biology classroom. That means leaning cycle helps address the limitations of the traditional model of teaching in science (Renner, 1982; Abraham, 1998). Learning cycle identifies misconceptions early and teachers easily stop teaching way and then redirect concept. Basically learning

cycle teaching approach overcomes misconceptions in three ways, concept understanding, improved problem solving, and better laboratory skills. First, in the concept understanding there are three ways to deal with misconceptions. (1) Semantic or concept mapping, which is a technique for representing knowledge in graphs, assess understanding or diagnose misunderstanding to help learning by explicitly integrating new and old knowledge, (2) Clustering, the process of finding groups for data, is very useful for teachers revealing misconceptions in student understanding because teacher can see whether student categorize correctly concept or not. (3) Mental modeling is asking open-ended questioning about concept, and is the best way whether students understand concept or not. Second, constructing knowledge by making mistakes is part of the natural process of problem solving, which is the foundation of a students' learning. Problem solving explains whether teachers' teaching design method helps students learn. Problem solving is an effort to convert an actual current situation into a desired future situation. Finally, lab skills, which is planning investigation, data gathering, testing hypothesis, interpreting results, and drawing conclusion, is the another way to students' understanding about concept. Learning cycle provides all these techniques (Marek & Fleener, 1992).

Conclusion

In the curriculum of learning cycle, teachers should use a multidisciplinary approach that integrates technology with effective learning and teaching practices. A teacher who expects to point out students' misconceptions to them will be met with little success. Generally students study very hard to process information and reach at their ideas. It is not easy to deconstruct these ideas and let go of incorrect ones.

As a solution, although some teachers say using learning cycle requires too time in preparation and structuring lesson, even how the preparation for learning cycle lesson is extensive (Rubba, 1992), they agreed that if the plans are made, students become active and participant in their learning by asking questions, experimenting, researching, communicating with their classmates, and drawing conclusion. In Learning Cycle approach, students are responsible for some part of the learning on their own. In exploration phase of learning cycle, students take responsibilities and gain self-confidence by being able to do something and then it is easy to solve problems themselves.

Consequently, the misconceptions held will most likely require direct experience to be effectively corrected. A learning environment, where disequilibration occurs followed by accommodation under the guidance of the instructor, is required if misconceptions are to be resolved or prevented from being established (Piaget, 1964). So Learning Cycle approach, originated from Piaget's model of intelligence, curriculum suggests that our curriculum should be developed in a way that it leads to students to disequilibrium, and teachers have to make connection between real world and science concept (Haidar & Abraham, 1991). This is the one of the ways to get rid of wrong preexisting knowledge from students' minds. If student is in disequilibrium, s/he is in the process of constructing new knowledge and trying to fit them into their educational schema, Learning Cycle approach causes student to ask question his/her old ideas and presents new ideas as plausible and useful. Therefore learning cycle approach is effective in altering students' science content misconceptions.

Teachers Role

Teachers have some roles to overcome the students' misconceptions. The first step is to diagnose students' misconceptions. The next is to find out the best solution about that. As teachers, we should focus on students cognitive level to eliminate misconceptions, because most of the students in high school and all students in elementary and junior high are in concrete level; therefore, the major focus of instruction for those students should link between concept and concrete experiences and expect difficulties on linking concrete experience to abstract concepts because any science concept has a relationship with other concepts, so students have to link the ideas and other concepts. When students create this linkage in their mind, they are going to correct their misconceptions and develop meaningful understanding of new concept. Learning Cycle allows students to make this linkage therefore eliminate misconception (Abraham, Williamson & Westbrook, 1994; Aydoğan, Güneş & Gülçiçek, 2003; Cavallo, 1991**;** Marek, 1981-1986; Marek, Covan & Cavallo, 1994). Marek (1981) suggested that the highest priority for science teacher is to pay attention to cognitive development. Abraham, Williamson, and Westbrook (1994) suggested that if we want to decrease misconceptions, we have to increase experience. Only laboratory activities (exploration phase of learning cycle) recall the concepts and makes students to clear understand than any other teaching methods. For example, tenth grade biology students in Marek's study (1986) told that "experience makes concept more believable and understandable" (p. 40).

Another role of teacher is to realize his students' capacity and to consider in curriculum development and appropriate hands-on activities because "the students with high IQ's has greater achievement of inquiry skills than the students with low IQ" (p. 13) because Marek & Renner (1979) showed that inquiry teaching method increased IQ test scores, content-achievement, inquiry skills achievement, intellectual development.

Learning Cycle approach pushes teachers to use educational technology in their science lessons. Generally teachers using learning cycle approach prefer to use computer and video in the exploration and concept application phase. As known, technology as a part of classroom activities is motivating, and allows students to learn, communicate, and share their knowledge and understanding in a wide variety of ways. Recent studies showed that the influences of technologies in the science classroom even inquiry and/or laboratory based science teaching are undoable in a positive way (Büyükkasap, Düzgün, Ertuğrul & Samancı, 1998; Marek, Askey & Abraham, 2000; Saka & Akdeniz, 2006) and treatment with technology decrease misconception (William & Abraham, 1995).

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