EFFECT OF PHYSICAL MODELING AND COMPUTER ANIMATION IMPLEMENTED WITH SOCIAL CONSTRUCTIVIST INSTRUCTION ON UNDERSTANDING OF HUMAN REPRODUCTIVE SYSTEM

A THESIS SUBMITED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSTY

BY

GONCA ESENDEMİR

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
SECONDARY SCIENCE AND MATHEMATICS EDUCATION

JANUARY 2014

Approval of the thesis:

EFFECT OF PHYSICAL MODELING AND COMPUTER ANIMATION IMPLEMENTED WITH SOCIAL CONSTRUCTIVIST INSTRUCTION ON UNDERSTANDING OF HUMAN REPRODUCTIVE SYSTEM

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ABSTRACT

EFFECT OF PHYSICAL MODELING AND COMPUTER ANIMATION IMPLEMENTED WITH SOCIAL CONSTRUCTIVIST INSTRUCTION ON UNDERSTANDING OF HUMAN REPRODUCTIVE SYSTEM

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Ph. D., Department of Secondary Science and Mathematics Education

Supervisor: Prof. Dr. Ömer Geban

January 2014, 251 pages

Main purpose of the study was to compare effectiveness of the physical modeling and computer animation implemented with social constructivist and traditionally designed instruction on 10^{th} grade students' understanding of human reproductive system, motivation towards learning biology and types of achievement goal orientation. Design of the study was quasi-experimental with 125 students from six intact classes in a private high school in Ankara. Three groups for both experimental and controlled groups were randomly assigned. Students in the experimental group were instructed by computer animation and physical modeling implemented with social constructivist instruction, while students in the control group were instructed with traditionally designed biology instruction.

Human Reproductive System Conceptual Test (HRSCT), Student Motivation towards Biology Lesson Questionnaire (SMTBL), Achievement Goal Questionnaire (AGQ) were administered as a pre- test and post- test to assess students' understanding on human reproductive system concepts, motivation towards learning biology and types of achievement goal orientation according to the 2x2 achievement goal framework. Science Process Skill Test (SPST) was given at the beginning of the study to determine students' science process skills.

Results of MANOVA indicated that experimental group showed significantly better acquisition of the scientific concepts in addition to improving students' motivation towards biology learning as a school subject than traditionally designed biology instruction. Analysis of covariance (ANCOVA) showed that students in control group had significantly higher tendency to have performance approach and performance avoidance goals. In contrary there is no significant difference between mastery approach and mastery avoidance goals in between two groups.

Keywords: Physical Modeling, Computer Animations, Social Constructivism, 2 x 2 Achievement Goal Orientation, Motivation

ÖZ

MODELLEME VE BİLGİSAYAR ANİMASYONLARI DESTEKLİ SOSYAL YAPILANDIRMACI YAKLAŞIMIN İNSAN ÜREME SİSTEMİNİ ANLAMAYA ETKİSİ

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Bu çalışmanın başlıca amacı modelleme ve bilgisayar animasyonları destekli sosyal yapılandırmacı yaklaşıma dayalı öğretim yönteminin onuncu sınıf öğrencilerinin insan üreme sistemi konusuyla ilgili kavramları anlamalarına, biyoloji öğrenmeye yönelik motivasyonlarını artırmaya, başarı yönelimlerine etkisini geleneksel biyoloji öğretim yöntemi ile karşılaştırarak incelemektedir. Bu çalışma Ankara'da özel bir lisede, altı farklı sınıftan toplamda 125 öğrencinin katılımıyla gerçekleştirilmiştir. Rastgele seçilen üç deney grubunda modelleme ve bilgisayar animasyonu ile desteklenmiş sosyal yapılandırmacı yaklaşım yöntemi uygulanırken, kontrol grubundaki öğrencilere geleneksel biyoloji öğretim yöntemi uygulanmıştır.

İnsan üreme sistemi kavram testi, öğrencilerin biyoloji öğrenimine yönelik motivasyonu ve başarı yönelimi ölçeği ön-test ve son-test uygulanarak öğrencilerin insan üreme sistemi konularını kavramaları, biyoloji öğrenmeye yönelik motivasyonları ve 2x2 çerçevesinde başarı için hedef belirleme yönelimleri incelenmiştir. Bilimsel işlem becerilerini belirlemek üzere ön-test olarak bilimsel işlem beceri testi uygulanmıştır.

MANOVA analiz sonuçları deney grubunun insan üreme sistemi konusu kavramlarını anlamalarında ve biyoloji öğrenmeye yönelik motivasyonlarını artırmada kontrol grubuna göre daha etkili olduğunu göstermiştir. Ayrıca Ortak değişkenli varyans analizine (ANCOVA) göre kontrol grubundaki öğrencilerin performans yaklaşma ve kaçınma yönelimlerinin deney grubuna göre daha yüksek olduğu bulunmuştur. Bununla beraber öğrenme yaklaşma ve kaçınma yöneliminde her iki gurup arasında anlamlı bir fark bulunamamıştır.

Anahtar Kelimeler: Modelleme, Bilgisayar Animasyonları, Sosyal Yapılandırmacı Yaklaşım, 2 x 2 Hedef Belirleme Stratejileri, Motivasyon

TO MY FAMILY

ACKNOWLEDGEMENTS

I would like to express my genuine gratitude to my supervisor Prof. Dr. Ömer Geban who has given great support to me throughout my research. This study wouldn't be possible without his guidance, advice, criticism, encouragements and suggestions.

I would like to express my sincere appreciation to my friends for their encouragements throughout the study and to all of my collegues who have applied the methods.

I am particularly like to thank to my parents and my sister for their trust that provided me confidence.

Finally, I would like to thank to students who devoted their time and participated in this study.

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AGQ: Achievement Goal Questionnaire

HRSCT: Human Reproductive System Conceptual Test

SMTBL: Students Motivation towards Biology Learning Questionnaire

SMTSL: Students Motivation towards Science Learning Questionnaire

SPST: Scientific Processing Skills Test

TDI: Traditionally Designed Instruction

PMCAII: Physical Modeling and Computer Animation implemented with Social Constructivist Instruction

SE: Self- efficacy

PG: Performance Goals

AG: Achievement Goals

ALS: Active Learning Strategies

BLV: Biology Learning Value

SLV: Science Learning Value

LES: Learning Environment Stimulation

MA: Mastery approach goals

MAV: Mastery avoidance goals

PA: Performance approach goals

PAV: Performance avoidance goals

PMA: Pre- Mastery approach goals

PMAV: Pre- Mastery avoidance goals

PPA: Pre- Performance approach goals

PPAV: Pre- Performance avoidance goals

EG: Experimental Group

CG: Control Group

N: Number of students

SD: Standard deviation

F: Effect size

df: Degrees of freedom

SS: Sum of squares

MS: Mean of Square

p: Significance level

F: F statistics

t: T statistics

CHAPTER 1

INTRODUCTION

Concept change and conceptual changing is an important aspect of education according to the constructivist point of view. In this point of view students come to the classrooms with prior knowledge, which can either be scientific or nonscientific (Martin, 2006). The ones that are not scientific are mainly nominated as preconceptions or misconceptions (Driver & Easley, 1978). Therefore this situation places an important role for the educators in terms of understanding the students' misconceptions and seek ways to create conceptual change.

There are lots of researches that investigate the misconceptions or preconceptions about the biology topics, since some biological concepts such as genetics, photosynthesis and food web can be found by students as abstract, difficult, confusing and complicated. Therefore students have some common misconceptions about those biological concepts (Çetin, 2003). Human reproduction is one of the biology topics that students have some difficulties in forming concepts. The unit is important in terms of being a basis for the endocrine system. One of the reasons for nominating the unit as complicated is the need for understanding cell division, meiosis (Saral, 2008).

Meiosis is one of the biology topics that is found abstract, difficult and complicated by the students according to the biology teachers and researchers (Öztap, Özay & Öztap, 2003; Stewart & Dale, 1989; Stewart, Hafner & Dale, 1990; Smith, 1991; Chinnich, Neth & Sherman, 2006; Quinn, Pegg & Panizzon; 2009**).** One of the

reasons of common misconceptions in meiosis topic, according to the study of the Flores (2003) was that students were not able to express and recognize the differences between some processes at organism and organ level. In addition by considering other researches it could be concluded that main part of the problems are originated due to the confusion of the terms and steps in meiosis.

In contradiction with the difficulty of meiosis, most of the researches about the meiosis topic in education field are mainly about its use in genetic topic (Lewis & Kattman, 2004; Wynne, Stewart & Passmore, 2001) or only to derive out the misconceptions (Flores, 2003). There is not much study that is searching for an effective way to create a conceptual change about the phases and terms of meiotic cell division.

In addition to the misconceptions in meiosis, other sub- topics in human reproduction can also lead to misconceptions easily. According to the study of Veiga, Teixerira, Martins & Silvestre (2006) throughout a person's life, students gain information from both scientific and nonscientific sources about human reproduction. So they accept/ reject behaviors, construct value differences, build up their own orientations and limiting concepts due to the knowledge that they have gained. In addition their sexual education begins within the family in addition to friends that they perceive as knowledgeable. This could lead wide range of prior knowledge with lots of misconceptions. Therefore school has an important responsibility in terms of finding out the misconceptions and creating a conceptual change. Even if it is addressed as a difficult topic it is important to create deconstruction in order to prevent transmission of the sexually transmitted diseases as well. Within the same study it is also emphasized that, deconstructing students' ideas that are formed with false and traditional morality is difficult.

Conceptual change requires accommodation of new ideas and reorganizing or replacing the existing conceptions (Smith, Blakeslee & Anderson, 1993). It implies that a learner actively and rationally replaces existing pre-scientific conceptions with scientific acceptable explanations as new propositional linkages are formed in his framework (Alkhawaldeh, 2007). In teaching for conceptual change students must experience contradiction with their expectations. It is only reasonable that students would not accept a new idea, unless they realize that their existing concepts are unsatisfactory in some way. Posner, et al., (1982) suggest that if students are going to change their ideas, students must become dissatisfied with their existing conditions. Later on the scientific conception that they replaced with the previous must be intelligible, appear plausible and useful in a variety of new situations (Coştu, Ayas, Niaz, Ünal & Çalik, 2007).

Conceptual change model is a teaching/ learning model that creates a change in conceptions. As cited in the study of Coştu, et al., (2007), the model is developed by many science educators like; Clement (1987), Duit (1987), Posner, et al.,(1982) and Stephans (1991). The model is composed of six stages. First stage is that, students realize their own conceptions in the beginning of the instruction by thinking or making predictions before the instruction. Later on they express their concepts by sharing them within small groups. Third stage is the confrontation of the concepts by checking and discussing them in groups. Then students try to solve conflicts between their ideas and their observations during the accommodation of the new concepts. Fifth step is that they extend the concepts by trying to make connections with the daily life. And the last step is encouraging students to go ahead and deal with extra questions and problems for the concept (Coştu, Ayas, Niaz, Ünal & Çalik, 2007). Therefore in a classroom environment by emphasizing the common misconceptions of the students, and trying to explain the reason of their misconceptions by using the activities, the accommodation of new information can be provided. Therefore conceptual change will be acquired. In order to understand the improvement in the conceptual change pre and post test can be applied to the sample.

According to the literature in order to create a conceptual change related with the misconceptions in human reproduction, constructivist methods can be beneficial. Constructivism is considered as a meaning making theory or an epistemology that releaves an explanation about how human beings learn and the nature of the knowledge. It states that individuals create their own new understandings or knowledge through the interaction of what they already know and believe and the ideas, events and activities that they experience (Haqq, et al., 1998). However according to the Earns Von Glasersfeld, rather than describing constructivism as an epistemology or theory of knowledge it is more appropriate to consider as a theory of knowing. The main reason of this is that, according to constructivism, the knowledge is not global or same for everybody, therefore by stating it as theory knowledge, it is implied as, there is a global knowledge (Glasersfeld, 1995)

The importance of how we perceive reality is another main point for Earns Von Glasersfeld (1995), in terms of constructing the knowledge. One of the citations that he supports his idea is from the Wittgenstein, that implies that in order to decide whether a picture is true or false, a comparison must be done with the reality. Additionally what is stated by reality depends on the individual. He also emphasized different perceptions derived according to the language use. He gives the sentences "I like the boy" and "questo ragazzo mi piace" as an example. The both sentences are implies the same thing. However in English the active person is the girl, but in the Italian one, the active person is the boy. Therefore according to Earns Van Glasersfeld, the use of language also creates different conceptualizations (Glasersfeld, 1995).

If we compare constructivism with the objectivism, that is knowledge exist independently of learners and learning consists of transferring that knowledge from outside to within learner as the individual experience of it, the main difference is that the knowledge is not independent form the individual. In addition, the individual is active during the construction process. Therefore cognition of the person is important

(Driscoll, 2005). In constructivism what children learn is not a copy of what they observe in their surroundings, but the result of their own thinking and processing (Martin, 2006). In contrast from their differences, both of the theories imply that there is a real world that we experience (Duffy & Jonassen, 1992). In addition constructivist approaches emphasize production of greater internalization and deeper understanding than the traditional methods (Haqq &Ismat, 1998).

According to the Umass (2008) several features of the constructivist theory leads to learning or meaning making. One of those points is that knowledge can not be transferred. Rather than transferring the knowledge to an individual directly, it must be considered that it can only be constructed by the individual. In addition prior knowledge of the individual also has an effect on the knowledge that is going to be constructed. Other important feature is that initial understanding of the individual will not be global but local. Lastly since knowledge is constructed by the individual it has to be kept in mind that it will require purposeful activities and efforts.

In general two interpretations of constructivism can be found among contemporary educators. One of them is the psychological constructivism that is articulated by Piaget. The other one is the social constructivism that is associated with the Vygotsky. There are two majorities that creates these interpretations; the comparison of education for the individual development and social transformation and the degree of influence of social context on the individuals' cognitive development (Haqq & Ismat, 1998). In addition to these two interpretations there is also the third one which is radical constructivism. It embraces with the construction of mental structures, the position of cognitive constructivists, and the construction of personal meaning (Doolittle, 1999).

Vygotskian constructivism emphasizes education for social transformation. It states a human development theory within a social context. According to the approach

individuals' interaction within which cultural meanings are shared by the group are internalized by the individual. The construction of knowledge is in transaction with the environment. According to those interpretation schools are the cultural settings or cultural tools, where teaching and learning take place. The theory and practice shaped by dominant cultural assumptions. Moreover formal knowledge and the presentation of it are influenced by the cultural environment. To acquire the goals of social transformation and reconstruction, the context of the education must be deconstructed, in addition to exposing and criticizing the cultural assumptions, power of relationships and the historical influences must be emphasized (Haqq & Ismat, 1998).

According to Driscoll (2005), problem solving reasoning, critical thinking, active and reflective use of knowledge is parallel instructional methods with constructivist approach. In terms of Vygotsky' s social constructivist approach introducing obstacles that disrupt normal problem solving, providing external aids that can be used in different ways and asking problems that exceed students' knowledge and skills are important to emphasize process rather than the product. In order to maintain differences in mental functioning it is important to create a social organization that includes division of labor. Moreover usage of tools- something that can be used in the service of something- and signs- stands for something else- are important aspects of social constructivism. There are three types of signs which are indexical (show cause and effect relationship), iconic signs (images or pictures of the objects that they refer) and symbolic signs (show abstract relationship with other objects and events they refer). Internalization of the newly gained knowledge; zone of proximal development which is the difference between what a learner can do without help and what he or she can do with help; and scaffolding are the important points that are needed to be focused.

Williams (2011) conducted a research about social constructivism and its effect on student attitudes, understanding of biological concepts and their long term retention

in a biology class with the topics genetics, biotechnology and evolution. According to the result social constructivism create the highest difference in terms of the level of the student motivation and attitude. In addition students understanding and retention of concepts increased by the usage of the social constructivist approach. Another study was conducted about social constructivism by Bay, Bagceci & Cetin (2012) about its effects on problem solving and metacognitive awareness. According to the results that the research reveals there was a significant difference in the favor of the experimental group which was instructed with social constructivism with regard to traditional group. Wu & Tsai (2005) revealed a similar result about constructivism. In the study effects of constructivism oriented instruction on cognitive structures about biological reproduction was investigated. Again the study revealed that students in the experimental group which was treated with constructivist approach accomplished better learning outcomes both in terms of understanding and cognitive structures. Moreover according to the study of Ilyas, Rawat, Bhatti & Malik (2013), groups that are taught with social constructivism showed significantly higher achievement levels on Algebra.

In order to create a better understanding representations are also useful. Goldin & Shteingold (2001) stated that they are useful in terms of leading students from concrete to more abstract thought. According to Bruner (1966) there are three different types of representations, which are also important in Vygotskian constructivism, enactive, iconic and symbolic. Driscoll (2005) cited that Vygotsky suggests reaching to higher mental processes occur when social relations converted into mental functions and for that purposes usage of representations are important in terms of mediating to internalization with symbolization.

Ross & Willson (2012) conducted study about the effects of representations, constructivist approach and engagement of the students on conceptual understanding. Again both of the factors increase the student's procedural and conceptual understanding. Moreover to create an appropriate environment for the conceptual

change for the topic meiosis Smith (1991) suggested to create a context in the classroom environment that is embedded with cell cycle, use of diagrams, pure understanding of the terms, focus on the activities of the chromosomes, de-emphasization of other cytological events, presentation of cell cycle as a continuous process, use of overhead projector, modeling meiosis and well planned analogies. In addition according to research of Öztap, Özay & Öztap(2003) that is conducted in Turkey 44,4% of teachers use diagram, pictorial materials and slide, 16,66% use video films, 27,77% use models and 25% use laboratory facilities for the topic meiosis. Other researches about teaching genetics and meiosis also reveals that the main techniques that are used are computer based animations and physical modeling (Locke & McDermid, 2005; Quinn, Pegg & Panizzon, 2009; Rotbain, Marbach-Ad & Stavy, 2006; Rotbain, Marbach- Ad & Stavy, 2007; Bogiages & Hitt, 2008). Study of Heafner & Friedman (2008) also showed that usage of constructivist approach by the help of the wikis resulted in a better content retention in addition to creating better understanding, high self- efficacy and motivation when it was compared with teacher- directed instruction. It was also stated that in such a context wikis helped student understanding by integrating content both literally and figuratively. Also they have a role in creating deeper understanding by visualization of the sequence of events in addition to cause and effect relationships.

Since Human Reproduction Unit in biology composed of mostly cause and effect relationships with sequence of events as in the case of meiosis, oogenesis and spermatogenesis in addition to hormonal control it is important to enhance effect of social constructivism with usage of representations. Also most of the events take place in micro level which is abstract and difficult for the students to visualize. For that purpose computer animations and physical modeling can be integrated to social constructivism as well. According to Gardner (1983) in such an environment computer animations provide a language tool. Computer based animation attempts to simulate an abstract model of a particular system. It can be used as an aspect of reality that would be otherwise impossible to be explored within the classroom context. It shows the concepts, in concrete and manipulative forms in addition to

preventing impact of the point of view of textbook writer or the instructor. Therefore computer animations enable students to experience phenomena by themselves (Trindade, Fiolhais & Almedia, 2002). Dynamic nature of the processes is presented by animated color graphic images (Kiboss, Ndirangu & Wekesa, 2004) and motion of the events is shown by the two dimensional computer animation models (Daşdemir, Doymuş, Şimşek & Karaçöp, 2008). It is suggested to use computer animations in concepts which are difficult to understand in addition to difficult to visualize since they are related with micro level processes (Rotbain, Marbach- Ad & Stavy, 2007). In addition to serving as a tool for better understanding, animations can have different roles in education such as increasing motivation, taking attention, and giving extra information (Weiss, Knowlton & Morrison, 2002).

Rotbain, Marbach-Ad & Stavy (2007) constructed a research about the effect of use of computer animation on student achievement in molecular genetics. They figured out that when teaching about dynamic processes computer animation has a great importance and increase the achievement of students especially on open- ended questions. A similar study conducted by Yakışan, Yel & Mutlu (2009) on diffusion, osmosis, active transport, protein synthesis, mitosis and meiosis. The study revealed that there was a significant difference in the favor of the experimental group which was taught with the computer animations. Study of Aksoy (2013) revealed the same result as well. Students' comprehension of the "Solar System and Beyond" unit was investigated while comparing effects of computer animation with traditional method. The result showed a siginficant difference in the achievement level of students' in the favor of the experimental group treated with computer animations. Study of Daşdemir, Doymuş, Şimşek & Karaçöp (2008) revealed the same result on teaching acids and base. Moreover according to the study of Williamson & Abraham (1995), by the use of the computer animations treatment group had significantly higher conceptual understanding scores than the control group. On the other hand according to the study of Hsu& Thomas (2002), in terms of conceptual progress in science lessons there is no significant difference between the groups that are used simulations between the post test scores. But it is important to state that the

instrument of the research is composed of multiple choice questions and for the Rotbain, Marbach-Ad & Stavy (2007)' s research it is known that main difference is figured out in the open ended questions.

Physical modeling is one of the other ways to enhance social constructivism in terms of creating conceptual change. A physical model is used in various contexts to mean a physical representation of something. That thing may be a single item or object (for example, a bolt) or a large system. In the case of models and modeling in science education, models are used as the source analog, which then act as an instructional tool in reasoning about the target analog and for understanding a new concept. In addition it is also believed both by teachers and scientists that analogical models help students to construct and manipulate mental models of abstract processes. The important point is to make the analogies easily understood by the students and be remembered (Rotbain, Marbach-Ad & Stavy, 2006). In the literature when it is searched for the modeling, the main attitude is either for cognitive modeling or the computational modeling. There is not much search for the physical modeling. One of the researches about physical modeling indicates that the students that instructed with illustration models and physical modeling techniques improved their knowledge in molecular genetics when it is compared with the control group. Additionally it is shown that the physical modeling activity is significantly more effective than the illustration activity (Rotbain, Marbach-Ad & Stavy, 2006).

Moreover both by using computer based animations and physical modeling the unit human reproduction can be delivered by the social constructivist approach. According to the objectives of the lesson, animations can be beneficial if they are supported by the related social constructivist activities especially in the physiological processes. This is something in concordance with the literature review of the computer based animations. In addition in order to construct the anatomical arrangement of the human reproductive system organsand processes, it is beneficial

to use modeling, it can be also applied in the meiotic cell divisions that will represent the basis for the gamete formation, both spermatogenesis and oogenesis.

While creating a conceptual change about the human reproductive system with computer animation and physical modeling integrated social constructivist approach importance of the students' intrinsic behavior cannot be neglected. Once positive effects are created on the intrinsic behavior it is easier to create a better understanding about the concepts. One of the main domains of the intrinsic behavior is the students' motivation towards learning. There is more than one definition of motivation but "in general, is the process that plays a major role in an individual's choice of and continued engagement in particular activities" (Credler, 2005, p. 380). As cited from Başer (2007) according to Ormrod (2006) students energize, direct and sustain their behavior by motivation. Moreover he believes that students figure out particular directions and keep walking through them by their state of motivation. Targets are determined by the individual according to the goals they set. In order to reach their goals students may participate in tasks either mentally or physically. In addition to this definition, motivation was defined as a force that an individual participate to an activity by being internally conditioned (Elliot, Kratochwill, Littlefield and Travers, 2000; Pintrich & Schunk, 2002). Rather than direct observation, by the help of presence of the behaviors like "choice of tasks, efforts, persistence and verbalizations" motivation can be identified (Pintrich & Schunk, 2002, p.5).

Tuan, et al., (2005) suggested that students' motivation towards science learning composed of different subscales which are self- efficacy, active learning strategies, science learning value, performance goal, achievement goal and learning environment stimulation.

Self- efficacy is students' perception about having the means to learn or perform effectively. Also students' believes about the ultimate end of performance is considered as outcome expectations under the heading of self- efficacy (Bandura, 1997). It is a belief of the individual about the possibility for having grade A from a course. Consequence of this grade after graduation would be the outcome expectation of the person (Zimmerman, 2000).

Active learning strategies are another important aspect of the motivation. For Bonwell & Eison (1991) it is about creating environments which makes students to participate in doing things and focusing on the thing that they are doing. Zull (2011) supports the view and states that it is about students' perception on his or her own actions. Problem solving, inquiry, thinking and relevance of knowledge to daily life increase the value of learning according to Tuan, et al., (2005). It is mainly related with how students perceive value of learning (Başer, 2007).

Performance and achievement goals are two other important aspects of motivation. Achievement goals relates with the intrinsic motivation whereas performance goals are mainly related with extrinsic origins (Driscoll, 2005). An achievement goal is the students' willingness to complete a learning task in order increase his or her own competence (Tuan, et. al, 2005) whereas it is to increase competence relative to other people (Fetsco & McClure, 2005).

Lastly learning environment stimulation also effects students' motivations towards learning as well. It is again about perception of the student about the peer- peer and teacher- student interactions, teaching techniques and activities used by the teacher within the class (Tuan, et al., 2005).

As it is stated before Heafner & Friedman (2008) revealed that usage of constructivist approach by the help of the wikis resulted in a high self- efficacy and motivation in addition to conceptual understanding when it was compared with teacher- directed instruction. Moreover Williams (2011) conducted a research about social constructivism and its effect on student attitudes, understanding of biological concepts and their long term retention in a biology class with the topics genetics, biotechnology and evolution. Again the result shows that social constructivism create the highest difference in terms of the level of the student motivation and attitude. Moreover study of Campregher (2011) about the effects constructivist approach integrated with the usage of interactive white board revealed that both student learning process and learning styles influenced by the technique. In addition there is an increase in the students' level of motivation.

Watters& Ginns (2000) also conducted a study about effect of social constructivism on developing motivation. There is a significant difference in the favor of the group which was treated with social constructivism in terms of self- efficacy. Therefore it is a known fact that social constructivism in addition to representations have an effect on the level of students' motivation. Also in the studies about computer animations and motivation (Lin, 2011; Windschitl, 1998) it was revealed that usage of computer animations within instruction increases students' motivation. They are useful in terms of gaining attentions as well (Rieber, 2000). Moreover Lazarowitz & Naim (2013) stated that implementing physical models in an active learning environment develop students' active learning strategies which are also important aspects of students' motivation towards science learning according to Tuan, et al., (2005). Therefore usage of social constructivism while enhancing the technique with physical modeling and computer based animations would help increasing students' level of motivation.

The intrinsic behavior of the students is a popular topic nowadays under the heading of self- regulation as well. There are different definitions for self regulation from

different researchers. One of the most known definitions is, being able to develop knowledge, skills and attitudes which can be transferred from one learning context to another and from learning situations in which this information has been acquired to leisure and work context (Boekaerts, 1999, p. 446). It is also defined as an active, constructive process whereby learners set goals for their learning and attempt to monitor, regulate, and control their cognition, motivation, and behavior guided and constrained by their goals and contextual features in the environment (Pintrich, 2000, p. 453).

Since self- regulation is defined in different ways by different researchers it can be concluded that there are different models to present self regulation (Boekaerts, 1999; Zimmerman, 2000; Winnie, 1995). One of the common points in all of the models is the goal orientation of the learner. According to the Boekaerts, goals provides an indication of why students are prepared to do and why they are or are not inclined to do what is expected of them (Boekaerts, 1999, p. 451). In addition it is also known that setting specific and difficult goals stimulate self regulation (Winnie, 1995).

According to the different studies it is known that there can be different types of goal orientations (Kaplan & Maehr, 2007; Deci & Ryan, 1985; Middleton & Midgley, 1997; Boekaerts, 1999; Elliot, 1999). In recent years goal orientations are also classified by Pintrich (2000) into four groups. In a way he adds mastery- avoidance and mastery –approach goal orientations (by dividing mastery goals into two) to the Elliots' classification. At first he differentiates types of achievement goal orientations as approach and avoidance. "Approach focus" states having positive relations with cognition, motivation and behavior related to these aspects of self regulated learning (Pintrich, 2000, p. 478). In addition to this "avoiding focus" can be labeled as the contrary of the "approach focus". Later on goal orientations are classified as mastery goals and performance goals. In general "Mastery goals" are defined as attempts to improve or promote competence, knowledge, skills and learning, and that standards are self-set or self referential with a focus on progress and understanding (Pintrich,

2000, p. 478). The student that has mastery goals may not value marks. They value their experience and the amount of learning. They measure these experience and amount of learning according to their feelings of understanding and interest (Carpenter, 2007). The main aim is the progress in the competence (Ames & Archer, 1987). According to the Carpenter (2007) mastery goal orientation can be measured by different names as task involved goals, intrinsic goal, learning goal and task-focused goal.

Pintrich also divides mastery goal orientations as "mastery/ approach focus" and "mastery/ avoidance focus". "Mastery avoidance focus" is the category that is added to the classification of goals of Elliot (1999). "Mastery/ approach focus" can be labeled as the one that focuses on mastering task, learning and understanding. The students that are labeled as mastery/ approach focus can be stated as a learner who concerns self- improvement, progress, deep understanding of task and learning. It is also stated that this type of goal can be named as "learning goal", "task goal", and "task involved goal". In contrast "mastery/ avoidance focus" can be labeled as avoiding misunderstanding, not learning and not mastering the task. The students that are labeled as "mastery/ avoidance focus" can be stated as a learner who concerns not being wrong and not doing it incorrectly according to the task. On the other hand Pintrich also stressed that there has been no empirical research on an avoidance mastery goal hence he states that the class "mastery/avoidance focus" is not a clear classification theoretically. According to Kaplan & Maehr (2007) little research conducted on mastery-avoidance goal as well and in the few published studies it is seen that this orientation is unrelated with cognitive strategies and grades whereas negatively related with intrinsic motivation. In addition its' positive relation with negative emotions like test anxiety and worry is stated as well. Besides these researchers, Nien & Duda (2008) has made one of the researches which shows "mastery /avoidance focus" has exists.

The contrary of “mastery goals” is the “performance goals” that is defined as trying to outperform or best others using normative standards (Pintrich, 2000, p. 479) and students who have higher tendencies towards the goal are more interested with how they perceived by other competents (West, 2013). Furthermore it is also explained as valuing of extrinsic rewards, focusing on elevating self when it is compared with others’ ability, being concerned with demonstrating one’s own ability in comparison to others (Carpenter, 2007, p. 9). According to Carpenter (2007), for the student with performance goals who have outperform in a test, the major thing is not to master new skills or retaining material but most of the time to receive an external reward like earning a high grade. Besides the name “performance goal”, according to the Carpenter (2007) it is also measured with the names extrinsic, ability approach, ability focused, relative ability and ego.

As in the case of “mastery goals”, Pintrich (2000) classifies “performance goals” into two as “performance/ approach focus” and “performance/ avoidance focus”. “Performance/ approach focus” can be labeled as focusing on being superior when it is compared with others, being the best and the smartest. The students that is labeled as performance/ approach focus can be stated as a learner who concerns in normative standards like getting best or highest grades or being best performer in the class. It is also stated that “performance/ approach focus” can be named as “performance goal”, “ego- involved goal”, “self- enhancing ego orientation” and “relative ability goal”. In contrast to “performance/ approach goal”, “performance/ avoidance focus” can be labeled as avoiding inferiority when it is compared to others and not looking stupid or dumb. The students that is labeled as “performance/ avoidance focus” can be stated as a learner who concerns in normative standards of preventing worst grades or in another words preventing being the lowest performer of the class. In the studies that differentiates “performance /approach focus” from “performance/ avoidance focus” emphasizes that “performance/ avoidance focus” are linked with negative outcomes such as low self- efficacy, anxiety, avoidance of help-seeking, self-handicapping strategies and low grades whereas “performance/approach focus” is linked with positive outcomes such as persistence, positive affect and grades.

While a student determines the types of goal orientation according to Elliot (1999), there are different variables that influence the decision. She states competence- based variables (e. g., need for achievement), self- based variables (e.g., self esteem), relationally- based variables (e.g., fear for rejection), demographic variables (e.g., sex), environmental variables (e.g., norm- based evaluation) and neurophysiological predispositions (e.g., BIS sensitivity) as the components in determining the types of goals.

As it can be seen from its components, type of achievement goal orientation determined by both internal and external components. According to Zimmerman (2000), learning environments have effects on the personal goals. Moreover desirability of mastery goals and performance goals depends on the achievement setting and the purposes expressed in that settings (Kaplan & Middleton, 2002). Study of Hanrahan (1998) in eleventh grade biology class on the constructivist epistemology and motivation revealed that how the technique implemented would have an effect on the students' motivation level in addition to the type of the achievement goal they would choose. If student autonomy would not be supported by the teacher tendency of the students' to have mastery goals violated. Implementation of small group projects, whole class discussions and practical inquiries in addition to students' perception about the methods that are used creates the type of the achievement goal they would prefer. Moreover Morrone, Harkness, D'Ambrosio & Caulfied (2004) conducted a study again about the social constructivism and its effect on the mastery goals in terms of its perception in the classroom in addition to its effect on problem solving ability and understanding of mathematics. According to the results, it has represented that social constructivist teacher perceived by the students as a promoter of mastery goals that leads students to higher order mathematical thinking in the classroom. This situation is explained by the scaffolding aspect of the social constructivism. Therefore social constructivist approach created an environment with mastery goals, which will effect students tendency on choosing achievement goals as Hanrahan (1998) revealed. On the other hand Summers (2006) showed out that social constructivism may end up with an

increase in the tendency of the students' to choose performance goals. Small groups with shared achievement goals show a change in the tendency of having performance avoidance goals. Under normal conditions students who do not meet their caring needs or do not have a best friendship that supports their validation prefer performance avoidance goals more than others. After the treatment students who are in groups which value academic goals prefer more likely performance avoidance goals since they value achievement goals of their peer learning groups in addition to valuing opinions of their group members. Therefore preventing embarrassment would be their first concern. Classroom practices with social constructivist approaches such as social learning and collaboration make students more self-conscious about the others' evaluations which lead to an increase in the performance avoidance goals. Same study also revealed that students who reported low social intimacy within the school and who would like to be known as popular rather than having intimate relationships with others have higher tendency to have performance approach goals than the others. Anderman & Anderman (1999) conducted a study about students' achievement motivation across the transition to middle school. Belonging in the school, social responsibility, relationship, status goals in the setting are the factors that explain the changes in the type of the achievement goal orientations. Students' perceptions of the task and ability goals emphasized in the classroom setting are important indicators to decide students' personal goals. Same study also reveals social perceptions are important in tendency of the type of achievement goal orientation that the students would have. Enhancement of the social responsibility goals increase focus on tasks whereas focus on the social goals like forming peer relationships and social status increases focus on self.

According to the literature it can be told that how the instructional technique implemented is important in terms of creating a change in the students' achievement goal orientations. That is mainly due to the perception of small group works. If social constructivism, especially the small group works create an area mainly focus on the tasks, rather than comparison, tendency to have performance goals decreases. On the

other hand if comparison is the main focus of the classroom context, than tendency to have performance goals increases.

1.1 Significance of the Study

In concordance with the findings in the literature the main purpose of this study is to investigate physical modeling and computational animation integrated social constructivist instruction is whether more effective than traditional teaching in terms of understanding concepts about the human reproductive system unit in addition to increasing students' motivation towards learning biology and creating a change on the tendency to choose different types of achievement goals in the tenth grade students in Ankara, Çankaya region. One of the hypotheses is that the instruction that the physical modeling and computational animation integrated social constructivist instruction will be more effective than the traditional instruction in terms of creating a better understanding. In the literature there are few researches that are conducted for directly searching a method especially integration of socal contructivism with different representatives to create a conceptual change in meiosis topic about the phases of meiosis. On the other hand it is known that meiosis is one of the foremost topics that students have lots of misconceptions. (Brown, 1990; Wynne, Stewart & Passmore, 2001; Flannery, 1999; Öztap, Özay & Öztap, 2003; Stewart & Dale, 1989; Stewart, Hafner & Dale, 1990; Smith, 1991; Chinnici, Neth & Sherman, 2006; Quinn, Pegg & Panizzon, 2009). Students learn this topic firstly in elementary school, and later on in the tenth grade. So when they are taught in the tenth grade they have already had a prior knowledge or some misconceptions about the topic. This is the same case for the human reproductive system. As the study of Veiga, Teixeira, Martins & Meliço- Silvestre (2006) reveals it is a topic that students are gaining information from both scientific and nonscientific sources and therefore have lots of misconceptions that are not easy to change. Moreover it is important to create a conceptual change related with those misconceptions mainly to prevent sexually transmitted diseases.

Human reproduction is also an important topic in terms of relating and forming a basis about both meiosis and endocrine system (Saral, 2008).

In the literature physical modeling and computational animation integrated social constructivist instruction not used to search for the amount of conceptual change in this important topic. One of the other hypotheses is that the instruction that the physical modeling and computational animation integrated social constructivist instruction will be more effective than the traditional instruction in terms of increasing students' motivation towards biology learning. Motivation is an important aspect in terms of both effecting understanding (Başer, 2006; Wigfield & Wentzel, 2007) and type of the achievement goal orientation chosen by the student by effecting self- regulation (Pintrich, 1999). Therefore it is important to investigate effects of the teaching technique on motivation to figure out the change it creates intrinsically which will shows its impact in a larger scale. Moreover the effect of physical modeling and computational animation integrated social constructivist instruction on increasing students' motivation towards biology learning in the topic of human reproductive system was not been searched as well. The other hypotheses is that the instruction that the physical modeling and computational animation integrated social constructivist approach implemented will be more effective than the traditional instruction in terms of changing tendency of the students to towards towards mastery oriented goals (Morrone, Harkness, D' Ambrosio & Caulfied, 2004). Working within groups and the context of the socioconstructivist classroom creates shared social and academic goals within groups which would effect the type of achievement goal student will prefer. Moreover how would group work would effect is not clear, since it is mainly effected by the implementation of the instructional approach. In addition the topic is not searched by considering the effect of the computer animation and physical modeling integrated social constructivist instruction. Therefore the study may open a path for school teachers in terms of showing the effectiveness of the instructional methods and the implementation in the lessons. Moreover the study will also have important impacts on the education field in terms of comparing instructions that are integrated with computer based

animations and physical modeling social constructivist approach over the traditional methods, and may lead to a wider comparison with different grade levels and different topics. Comparison of the methods over different grade levels and different topics will lead to an understanding of whether the effects of the methods may change due to these variables.

The main limitation of the study is due to the sample size since the sample size of the study is small it will create a limitation during generalization of the study in addition to the attitudes of the instructors and the subjects towards the instruction techniques and the instructor with respectively. If the instructor is in the favor of one of the techniques that the effect will be investigated it may cause a bias. Also the classes may compose of students that are in the favor of one of the methods, rather than homogeneity, therefore the results of the research will be affected by the situation. The conditions of the classroom environments and history may also affect the research. One of the classrooms' facilities can be better than the other which will again cause a difference between the two cases. Additionally the history of the classes may differ during the day, the previous lesson that they had will surely be different from each other. And at last the degree of novelty about the instructional techniques for the classrooms will effect the study as an extraneous variable.

The main delimitation of the study is the grade level. The study is restricted to tenth grade students. In addition the study will be conducted only in one school which is the other main delimitation. The restriction in the human reproductive system topic and searching for only the amount of understanding, motivation and type of achievement goal orientation chosen by the student are the other delimitations of the study.

CHAPTER 2

LITERATURE REVIEW

According to constructivism, students come into the classroom with prior knowledge, which is gathered by the daily experiences that they have interacted with. It is known that, some of the perceptions that they gathered from the daily experiences are in concordance with the scientific theories and some are not (McCormick, 2007). The ones that are not in concordance with the scientific perspectives are named as "alternative conceptions", "misconceptions" or "child science" (Martin, 2006). According to the studies it is known that students are emotionally attached to their misconceptions. Therefore it is difficult to change misconceptions ("Constructivism and Science," 2005). This situation increases the importance of conceptual change, which is one of the ways for eliminating the misconceptions (Hewson, 1992). To create an environment that ends with conceptual changes different types of techniques can be used. One of the useful instructional methods can be social constructivism (Williams, 2011). It can be enhanced by the usage of representations since they are useful in terms of leading students from concrete to more abstract thought (Goldin & Shteingold, 2001). Also they have a role in creating deeper understanding by visualization of the sequence of events in addition to cause and effect relationships (Heafner & Friedman, 2008). In addition to the instructional method it is important to consider intrinsic aspects such as motivation level of the students towards biology while creating conceptual change since students can be emotionally attached to their misconceptions. According to Ormrod (2006, p. 365) motivation gives energy, direct and sustain students' behavior. Therefore it is important to increase level of students' motivation towards biology learning to create better understanding of the concepts. By the help of

motivation they determine targets and keep walking through them. Target that is determined is the goal that the students set for themselves and it is a known fact that the approach of the instructor in addition to how it is applied may lead differences in the tendency of students towards different types of achievement goal orientations (Heafner & Friedman, 2008). In this study overall the effect of computer based animations and physical modeling integrated social constructivist approach on the understanding of human reproductive system, motivation towards biology learning and tendency towards different types of achievement goals was investigated. From this origin this overview will cover some of the literature related with conceptual change, social constructivism, computer based animations, physical modeling, motivation and achievement goal orientation. This chapter will provide a theoretical and practical background for the study as well.

2.1 Conceptual Change

In order to provide meaningful learning, ways must be searched to prevent misconceptions. One of the methods to prevent misconceptions is the use of conceptual change approach (Alkhawaldeh, 2007). In order to teach for conceptual change students must be given time to identify and articulate their alternative conceptions, investigate the soundness and utility of their ideas and those of others; and reflect on and settle differences in those ideas (Hewson, 1992).

The conceptual change model is a teaching/ learning model that provides time for students to identify and articulate their alternative conceptions, investigate the soundness and utility of their ideas and those of others; and reflect on and settle differences in those ideas to create conceptual change. The model is developed as researchers by many science educators. The model depends on five stages:

1. Students become aware of their own conceptions in the beginning of the instruction by thinking about it and making predictions before activity begins.
2. Students express and criticize their views by checking and discussing them in groups.
3. Students work to settle the conflicts between their ideas and their observations, by accommodation of a new concept.
4. Students extend concept by attempting to make connections between the concept learned in the classroom and other situations, including real life experiences.
5. Students encourage going further, by pursuing extra questions and problems related to the concept (Coştu, Ayas, Niaz, Ünal &Çalik, 2007).

In order to create conceptual change children must be dissatisfied with their existing conception. Their existing conception must be shown to fail to explain some new observation of an experience satisfactorily. When experimental evidences that the children rely on fail to provide support for a prior conception, the children begin to question the validity of the prior conceptualization (Martin, 2006). They become aware of the conflict between what they consider as true and what they have experience (Martin, 2006). As cited in Alkhawaldeh, Postner (1982) suggest that if students are going to change their ideas they must become dissatisfied with the existing conditions; the scientific condition must be intelligible; the scientific conception must appear plausible and the scientific conception must be useful in a variety of new situations (Alkhawaldeh, 2007). One of the ways for creating conceptual change is to use discrepant events, unusual happenings, to trigger children's curiosity about the validity of their prior beliefs (Martin, 2006). Collaborative teaching techniques, problem based instruction, inquiry based learning, conceptual change oriented texts, providing chances for predictions, and in depth discussions are some of the other methods that are used (McCormick, 2007).

If new conceptualization of the child appears more plausible as Postner suggests, it may accepted by the child as a tentative replacement for the prior notion. For the lasting acceptance three factors must be achieved by the child;

a) The new conceptualization must have explanatory power. Therefore it must propose a plausible explanation for each occurrence of the phenomenon.

b) The new conceptualization must have predictive power. It must accurately predict what is going to happen in new and yet inexperienced occurrences of the phenomenon.

c) The new conceptualization must utilize the input of others. Children have a tendency to discuss their ideas with each other in small groups. This provides them the opportunity to listen others for understanding their inputs as they formulate their own notions. The revise and refine their ideas as the other people criticize their ideas and ask questions that the child have never thought of it or offer suggestions to help students confront contradictions in their own thinking process (Martin, 2006).

In addition according to Keiny (2008), in the hypothetical three stage model for the conceptual change process, the conceptual change is indicated as an experimental change rather than a cognitive one. It can be considered as an intentional change of identity or a change of inter and intra relationships of the person with the world.

The main reason of the misconceptions in human reproduction system is due to the information gathered trough the life time of the students either by scientific and nonscientific sources. In addition students may feel shy to ask questions to the knowledgeable persons (Veiga, Teixeira, Martins & Maliço- Silvestre, 2006). In the study of Veiga, Teixeira, Martins & Maliço-Silvestre (2006), data is gathered from a sample composed of 148 teacher trainees of elementary education from the Portuguese public higher education institution. 142 of the participants were female and 6 were male. The age range is 20- 24 and 136 of the respondents were single and140 of them were Catholic. The aim of the study is to gain knowledge about the knowledge, behaviors and believes of these teacher trainees. To gather information about “what they know” and “what they say they feel and so” multiple choice

questionnaire, which is composed of seven sections, is applied. In its first section personal details are questioned like, sex, age, marital status, religion and political preference. In the second section trainee's over education and their views about education especially about sexuality and human reproduction is questioned. Moreover in the section two in what extend the trainees feel prepared to teach is also searched. As a third section data gathered about the trainee teacher's basic scientific knowledge of the anatomy and physiology of the reproductive system, namely regarding sex organs of men and woman, menstruation, ejaculation and fertilization. Fourth section is applied for the determining the behaviors of the respondents in the experience of their sexual behavior, and has quotations about their age at first sexual relationships, number and sex partners, type of sexual activity practiced, frequency of orgasm and masturbation, and contraceptive methods. Fifth section is for determining the motivations of the respondents engaging in sexual intercourse and in the sixth section is related with the knowledge about HIV virus. Lastly in seventh section beliefs about sex is questioned to determine the relationship between the views, current behavior and personal data. Validation of the questionnaire is carried with 10 similar students. As a result of the study 85% stated that they are not confident enough to teach this topic. And the same percentage also stated that they have committed scientific errors about physiological and anatomical aspects of the human body. In addition it is revealed that there is a lack of didactic materials, which does not compensate the obstacles. Moreover risky sexual practices are a probable reason for constructing their beliefs and may lead to an approach development about how to teach the topic.

To represent the misconceptions and the importance of the approach for delivering the human reproduction unit Saral (2008), conducted a study to search for the effect of case based learning on tenth grade students' academic achievement in the unit of reproductive system and their perceived motivation (Intrinsic Goal Orientation, Extrinsic Goal Orientation and Task Value). To conduct the research nonequivalent control group design was used. To gather data Human Reproductive System Achievement Test and Motivated Strategies for Learning Questionnaire is applied to

the sample of 80 tenth grade students which were composed of 48 males and 32 females that are instructed by two biology teachers in a private high school in Ankara. As the result of the study case based learning create difference in terms of increasing the achievement and improving high school students' perceived task value. On the other hand it doesn't make any effect on intrinsic and extrinsic goal orientation. Therefore study reveals that constructivist approach creates a difference in terms of increasing the achievement.

In addition to the human reproduction, its sub topic meiosis is shown as the one of the most difficult topic in biology education that students have misconceptions (Öztap, Özay & Öztap, 2003; Stewart & Dale, 1989; Stewart, Hafner & Dale, 1990; Smith, 1991; Chinnici, Neth & Sherman, 2006; Quinn, Pegg & Panizzon; 2009, Saral, 2008). It is also an important topic for understanding gamete formation and continuity of constant number of chromosomes within same species. Therefore it may easily lead students to misconceptions in human reproductive system topic. As cited in Brown (1990), Mitchell and Lawson describe domain specific knowledge for meiosis in terms of misconceptions is found out. Students' ideas about the duplication of chromosomes to chromatids, the separation part and the allele concept are the main problematic points. In addition according to the other studies the misconceptions in these areas creates problems in the genetics unit while solving monohybrid or dihybrid problems.

The main reason for the misconceptions is due to the confusion of the terms according to the Öztap, Özay & Öztap (2003). The research investigated the topics in biology that are labeled as most difficult topic to teach, what do teachers use as materials in cell division, the parts that they found difficult to teach in cell division, reason of the problems in understanding mitosis and meiosis and lastly the opinion of teachers about the use of laboratory materials in teaching cell division. Sample of the study is composed of 36 biology teacher who are working in secondary schools in Erzurum. The teachers involved in this research studied cell division and genetics

during their university education as a graduate student. Moreover questionnaires are used to figure out the difficulties in teaching cell division and materials that teachers use in their lessons during teaching cell division. In addition rather than using multiple choice questions for pursuing in-depth thinking open- ended questions are used. Questionnaires are distributed to the teachers and one week is given to get back the questionnaires from the teachers. According to the teachers the main reason of the misconceptions are due to the misconceptions in the cell division terminology. To overcome this situation use of models and pictorial materials are emphasized by teachers. In addition to the misconceptions about the terms, ultra structure of cell is not well known by students according to the teachers therefore it becomes difficult to visualize the process of cell division which in the end leads to misconceptions. Moreover according to the teachers it is figured out that the most difficult part to teach meiosis is the first part, especially the chromosome movements during prophase1. In addition to this DNA- chromosome relationships, mitosis and meiosis difference, and chromosome and genetic information link are the other points that are shown as the difficult part of meiosis to teach. One of the other studies about misconceptions in meiosis is conducted by Smith (1991). The sample of the study is composed of 6 students enrolled in undergraduate genetic course at private southeastern liberal art college and 50 students from southeastern public community college. 90 minutes Interview is made with the students from private school which make students discuss definition of a number of genetic terms and diagram mitosis and meiosis. The interviews are videotaped. From the 50 students from public community school again diagram of meiosis is asked either by surprise quizzes, homework assignment, sectional exam or final exam. At the end common misunderstandings are analyzed by using standard protocol analysis techniques. Findings of the study are in concordance with the previous study that was explained. Again main misconceptions are due to the terms of meiosis and chromosomal movements. The other study that represents the misconceptions in meiosis is done by Stewart& Dale (1989) by a sample of 50 students that half is from grades 9- 12 city school and half from rural- small city school grades 9-12. Each student took part in a problem solving/ interview session. In the study meiosis is investigated by linking it with Mendelian genetics as most of the other researches about meiosis. Thinking

aloud is the important part of the method. Later on open ended questions were applied to students. The results revealed the same misconceptions that the previous studies stated. In addition to them the misconception about the number of chromosome in the beginning and end of the meiosis is shown as an additional misconception. In addition to these studies Quinn, Pegg & Panizzon (2009) also research about the understanding of meiosis by using structural theoretical framework. The sample of the study is composed of 334 first year biology students. Practical and examination questions are applied to the students together with the interviews. Students written responses were coded by the researchers and hierarchically different categories are constructed. In addition the categories were supported by the answers of the students gathered from the interviews. The misconceptions that are pointed out are mainly the same with previous researches that I have stated.

From the researches about meiosis it can be concluded that the main reason for misconceptions are due to the misunderstandings of the definitions of the terms, chromosomal movements, number of chromosomes and microstructure of the cell that makes processes difficult to visualize. For overcoming the difficulties (Öztap, Özay & Öztap, 2003; Stewart & Dale, 1989; Stewart, Hafner & Dale, 1990; Smith, 1991; Quinn, Pegg & Panizzon, 2009) visualization in teaching meiosis is emphasized. Especially Öztap, Özay & Öztap (2003) and Smith (1991) underlined the importance of modeling. Moreover Öztap, Özay & Öztap (2003) also emphasized the importance of videotapes in teaching meiosis. Therefore in this study usage of computer animation and physical modeling will enhance the effect of social constructivism in terms of visualizing the concepts.

There are some studies to detect the effect of different methods on creating a conceptual change in the students. In the study of Çakır, Geban & Yuruk (2002), the effect of conceptual change test oriented instruction on students' understanding of cellular respiration concepts and their attitude toward biology as a social subject is

compared with the traditional methods. The sample of the study was composed of 84 eleventh grade students. There were four classes in total of a high school. Two classes were randomly assigned as the control group, and the other two were again randomly assigned as the experimental group. Moreover the experimental group was taught with conceptual change text- oriented instruction, whereas the control group was taught with traditional instruction. According to the results of the study it was found out that students in the experimental group performed better. Moreover no significant difference between the attitudes of the students in the experimental group and the control group toward biology as a school subject has been seen. The studies basic concern was students' misconceptions and the instructional strategies to affect the learning of scientific conceptions and the conceptual change from alternative to scientific conceptions. As a result of the study it was seen that the conceptual change text oriented instruction create a conceptual change from alternative to scientific conceptions in a better way, on the other hand did not create any difference in terms of attitude toward the school subject.

Problem based learning is another type of instructional conceptual change technique as it is stated before. In the study of Sungur, Tekkaya & Geban (2006), the effect of problem based learning on students' academic achievement and performance skills in the human excretory system is investigated. The sample of the study was composed of 61 tenth grade students. The sample was the composition of the two full classes. The classes were instructed by the same biology teacher. The study was an experimental study; therefore the classes were randomly assigned as experimental group and the control group. Pre and post tests were applied to understand the academic achievement and the performance skills of the sample before and after the treatment. The experimental group was taught with the problem based learning whereas the control group was taught with the traditional methods. As a result of the study experimental group performed better in terms of academic scores and performance skills that are required to accomplish problem solving. In addition students in the experimental group are more proficient in the use and organization of

the relevant information in constructing knowledge and moving toward better conclusions.

Cooperative learning is another important technique to create conceptual change. In the study of Tanel, Şengören & Kavcar (2006), the effect of cooperative learning strategies on the students' conceptual change is investigated on the subject of physics. 41 high school students constitute the sample of the study. The students in the physics class were divided into two groups. The experimental group is instructed with cooperative learning strategies in addition to the use of worksheet. On the other hand the control group is instructed with the traditional methods. Pre and post test has applied to understand the achievement of the students before and after the treatment. As a result of the study a significance difference between the groups in the favor of the experimental group has been found. So it is concluded that the cooperative learning methods improve students' conceptual change from the alternative conceptions to the scientific conceptions.

The study of the Çakır, Geban & Yürük (2002) did not include any cooperation implemented instructional techniques in the treatment. On the other hand in the study of Sungur, Tekkaya & Geban (2006), the cooperative learning techniques were also used as a part of the problem based learning. Furthermore the results of the study show a concordance with the results of the Tanel, Şengören & Kavcar (2006)'s study as well. There are no studies that compare the effectiveness of social constructivism that is enhanced by physical modeling and computer animation with the traditional methods, in terms of creating conceptual change within human reproductive system unit. Hence current study search for the effectiveness of computer based animations and the physical modeling integrated social constructivist approach in terms of creating a conceptual change. In the instructional technique both cooperative learning strategies and problem solving strategies will be integrated as well. The techniques that will be investigated are also in concordance with the suggestions for overcoming

the difficulties in teaching meiosis (Öztap, Özay & Öztap, 2003; Stewart & Dale, 1989; Stewart, Hafner & Dale, 1990; Smith, 1991; Quinn, Pegg & Panizzon, 2009)

2.2 Social Constructivism

Constructivism is one of the useful approaches for creating conceptual change. It is a known fact that it has positive effects on the students' motivation. One of the features of constructivism is that, knowledge cannot be transmitted but constructed by the individual. It is indicated that real learning can occur only when the learner is actively engaged in operating on, mentally processing, to the incoming stimuli (The Umass Scientific Reasoning Research Institute, 2008). Therefore the knowledge is constructed as the learners make an effort to make sense of their experiences (Driscoll, 2005). The open ended questions, inquiry based teaching, cooperative learning; problem solving can be some of the methods that make the students in the center of the teaching.

One of the other features of constructivism is the impacts of the prior knowledge. It is indicated that the children come into the classroom with ideas that are already in place about the natural world. Some of these ideas are in concordance with the accepted scientific understanding but some are not (Martin, 2006). In other words students come to the class with different experiences, ideas and explanations about the natural phenomena that are generally different from those generally accepted by the scientists. These different conceptions that are generated by students are called as "alternative conceptions" or "Children science" or "misconceptions". It is reported that misconceptions are spreading, stable and often resistance to change, most of the time by the traditional teaching methods (Alkhawaldeh, 2007).

In order to provide meaningful learning, ways must be search to prevent or at least eliminate misconceptions. One of the methods is the use of conceptual change approach (Alkhawaldeh, 2007). Teaching for conceptual change relies on a teaching strategy where students are given time to identify and articulate their alternative conceptions, investigate the soundness and utility of their ideas and those of others; and reflect on and settle differences in those ideas.

The other feature is that, the initial understanding is not global but local. Therefore knowledge that is constructed does not necessarily bear any correspondence to the external reality. They do not have to reflect the world as it really as since they are useful and plausible. Moreover there must be limits to what sense learners make of their environment and their experience. Limits are determined by the human biological characteristics as well as by what is possible in their reality. In addition reliable and systematic ways are required to test the observations and the sense they are making of the world around them (Driscoll, 2005).

The last feature of the constructivism is that building useful knowledge structures requires effortful and purposeful activity. The teacher or the facilitator is then expected to create purposeful activities to create construction. Embed learning in complex, realistic, and relevant environments; providing social negotiation as an integral part of learning; supporting multiple perspectives and the use of multiple modes of representation; encouraging ownership in learning and nourishing self-awareness of the knowledge construction process must be considered during the preparation of the activity (Driscoll, 2005). In Turkey creation of activities or student centered teaching perceived as the teacher is not doing his/ her job in a proper way. On the other hand it is known that it is more difficult to prepare an appropriate activity according to the level of the subject and the students rather than doing teacher centered teaching.

As I stated before there are different types of constructivist approaches, psychological, social and radical constructivism. This study focuses on the effect of social constructivism on different variables.

According to the social constructivist learning approaches knowledge is socially constructed (Duit, 2002). Peer/ social interaction in addition to group discussion are important factors leading conceptual change as stated in social constructivism (Uzuntiryaki, 2003). Moreover in order to create meaningful learning, active creation and modification of knowledge are the necessary components (Carey, 1985). Society culture and language are also the main components of social constructivism according to Driscoll (2005). Learning takes place in particular social and cultural contexts. Palmer (2005), states that by the help of the social interaction, interpretation of the physical and social world by the individual would be established. Learning increases when the interaction of the students with teacher and peers increases.

Scaffolding of the teacher as a guider would help students to develop knowledge and skills during making connections with pre- existing knowledge (Palmer, 2005). In order to create such an environment zone of proximal development of the student must be clearly identified which defines the functions that are not yet matured but are in process (Driscoll 2005). According to this approach, meaningful learning occurs when there are real-world-related authentic tasks which are related with any task but a way to respond to curricular content and by means of interaction and collaboration between experts and peers (Bay, Bagceci & Cetin, 2012).

Driscoll (2005) suggests that usage of signs promote decontextualization with the reasoning which is meaningful for the social constructivism. Teaching is not about content specific skills but many specialized abilities for thinking variety of things like teaching how- to learn or how to solve problem. To establish that computer

animations can be used since they create development of visualization skills and ability to think at micro level in addition to constructing physical models for developing problem solving abilities of the students'. Questioning is also important in order to achieve specialized abilities during prompting the students. As Driscoll (2005) cited from Tudge & Rogoff, (1989) learning usage of tools and skills they practice with their social partners are necessary aspects of social constructivism. In order to achieve this socially organized labor activities are important aspects of social constructivism also by considering individual differences while forming the groups. Partners must have shared understanding of task and means to accomplish. Moreover solving problems which creates a conflict or generate dilemmas with everyday situation is another important component. Discussions can be useful at this point if the teacher shifts it to clarify, reduce differences in understanding of the students. Also as a guider teacher should predict what might happen next (Driscoll, 2005).

Language would help students to seek for clarification with their peers in addition to sharing ideas. So it is important to create verbal thinking (Credler, 2005). With language and other signs such as iconic, symbolic and indexical, internalization takes place which extends students' understanding (Driscoll, 2005). Signs can be used for several purposes like; communication, guidance for developing mental abilities and internal cues in addition to monitoring or regulating one' s remembering and thinking (Credler, 2005). Moreover plays tools that are used should be the ones that would improve students' conceptual abilities and help them to develop a capacity for abstract concepts (Driscoll, 2005).

Therefore this study was also designed to investigate the effectiveness and potential benefits of computer animation and physical modeling in the line of social constructivist view. As there are difficulties in terms of understanding the biological concepts researchers who take a constructivist approach also recommend usage of models to enhance teaching (Rotbain, Marbach- Ad & Stavy, 2006; Malacinski &

Zell, 1996). Also Driscoll (2005) suggested the usage of signs which can be indexical, iconic and symbolic as a tool in Vygotskian social constructivist approach. So integration of physical modeling and computer animation would be in concordance with social constructivist approach. Trindade, Fiolhais & Almedia (2002) stated animations as they "enable students to experience phenomena themselves rather than through the eyes of a teacher or a textbook writer". As stated before constructivism is based on student, so it is important to make students experience the phenomena by themselves rather than making them trying to figure out from teachers eyes.

In addition to these it is a well-known fact that social constructivism increases understanding of concepts and achievement (Başer, 2006; Bay, Bagceci & Cetin, 2012; Ilyas, Rawat, Bhatti & Malik, 2013).There are several studies that prove social constructivism and its' positive impacts on the understanding. Williams (2011) conducted a study about the social constructivism and its effects on student attitudes and motivation, understanding of the biological concepts in addition to the long term retention of the concepts. Within the study three units were taught with different techniques for the same class. Class that was used was an advanced biology class from Roosevelt High School in the city of Honolulu with 1500 students that comes from three different neighborhoods with different socio economic levels. There were 25 students of which 19 of them were seniors, 5 were juniors and one was sophomore. Students had mainly different social backgrounds that showed many differences culturally. Topics that were taught were genetics, biotechnology and evolution. For each topic two weeks were spent. In the first unit which was genetics traditional techniques were used. The classroom applications mainly depended on the teacher lectures and hands on labs. Group works were also expected from the students but without implementing group activities which were socially constructive. For the other two units which were biotechnology and evolution social constructivist techniques were applied. Building social relationships with classmates were enhanced by the instructor. At the end of each unit section students assessed by short answer quizzes, essay questions for measuring understanding and 10- question

surveys for measuring attitude and motivation composed of both liker scale and short answers. Moreover with some students in- depth interviews were done with the teacher that questioned content and the methods of learning. According to the findings of the research students who engaged with their classmates liked the social constructivist teaching style. In addition teacher and students attitudes showed positive improvement. All of the students stated that they have enjoyed biotechnology and evolution units more than the genetics unit which was the only unit that was taught by using traditional techniques. Students stated that by social constructivism that their lab partners knew them better. To figure out the understanding level of the biological concepts average scores from the labs and post-unit assessments in addition to the essay questions were considered. For both of the assessment types, in the last unit, in which social constructivist techniques applied for the second time, there were a difference in the scores in the favor of social constructivism. Highest mean scores were observed for lab reports, post- unit assessment and essay in the evolution unit which was the third unit. It was concluded that there were an improvement in terms of understanding in the third unit, in which social constructivist techniques were applied for the second time, when it was compared with the first unit, in which traditional techniques were applied. On the other hand average scores for the second unit, biotechnology were lower than the first unit, genetics. This was explained by the novelty of the topics. Evolution and the genetics were not newly introduced topics. On the other hand biotechnology which was the second unit with lowest mean scores in contradiction with the social constructivist approach that was applied. Since genetics, which was unit 1, and evolution, which was unit 3, were not such a novel topics, it was logical to compare mean scores of them. Moreover when pre-assessment form of the students in biotechnology unit was investigated highest amount of gain can be observed in terms of conceptual understanding. Evolution unit, third unit, was the second in that sequence. Lowest amount of gain can be observed in the genetics unit which was taught by using traditional techniques. In addition highest amount of retention was seen in the evolution unit.

Another study related with social constructivism and understanding was conducted by Bay, Bagceci & Cetin (2012). The purpose of the study was to investigate the effects of social constructivism on the problem solving skills of the students and their cognitive levels. 137 teacher candidates were the subject of the study who attended to the "Principles and Methods of Instruction" subject in the faculty of education in Turkey. 89 of them were included in the experimental group that was treated with authentic task- based social constructivist approach and 48 were in the control group that is treated with traditional techniques based on subject- centered curriculum approach and meaningful learning approach. In the experimental group instructor serve as a mediator, in addition to active learners, as well as being autonomous and social. Semi- experimental design was used to search for the purpose. Control group and experimental group were assessed with the usage of pretest- posttest administration. For assessing problem solving skills, "Problem Solving Scale", and for measuring metacognitive levels "Metacognitive Awareness Scale" were used. Problem Solving Scale was composed of liker type 35 items with six alternatives that focuses on how people react and behave on the problems within their personal and daily life. Meta Cognitive Awareness Scale was 5- liker type scale with eight sub-factors. According to the findings of the study there were a significant difference both in problem solving skills and metacognitive levels of the teacher candidates in the favor of the experimental group. By increasing problem solving abilities, ability to generate one's own knowledge to solve problems individually was also increased. This ability is also parallel with understanding level of the individual **(**Sungur, Tekkaya & Geban, 2006).

Another study was conducted by Wu & Tsai (2005). Aim of the study was to figure out effects of constructivist oriented instruction on the cognitive structures about biological reproduction. Sample of the study composed of 69 elven years fifth graders in urban elementary school in Taiwan. Experimental study was conducted with control and experimental groups with randomly assigned two classes. 35 students assigned into constructivist- oriented instruction group, which was the experimental group whereas 34 students were assigned in the control group with

traditional instruction. Those two groups did not have any significant difference in science academic achievement, preferences and perceptions of science learning environments before the study. In the traditional group lecture and text based method was used. On the other hand in the constructivist oriented group both prediction-observation and explanation (POE) strategy and small group cooperative learning activities were used. Also constructivist method was enhanced by the usage of videotapes for the purpose of observation. Treatment took three weeks and the interview was done after a week from the instruction. Information was converted into flow- maps and information processing modes were investigated in those flow-maps. According to the result of the study, students in the experimental group showed better learning outcomes when it is compared with the control group. Both extent of concepts and richness within their cognitive structures were developed better than the control group. They acquire more concepts and developed more integrated cognitive structures. Additionally they store more concepts or ideas for describing related scientific information about biological reproduction. Besides these, students in the experimental group organize and store their ideas in higher level mode of information processing, mainly in the explanation level. Effects of science achievement on the development level of cognitive structures due to the constructivist oriented instruction also investigated in the study. As a result of this investigation development in the cognitive perspective was only discovered in the high achievers of constructivist oriented instruction group. In contradiction with these low achievers who attended to constructivist oriented instruction developed more extended and linked cognitive structures when it was compared with the ones' who attended to traditional group.

Ilays, Rawat, Bhatti & Malik (2013) again conducted a quasi- experimental study about Vygotsky's social constructivist approach and its effect on the learning outcomes of the seventh grade students in Pakistan. 54 Students who attended to public schools of Government Boys High School in District Jamshoro Sindh were the subject of the study. They were all male students in the two existing in- tack math classes. Two sections were selected as quasi control and treatment groups for the unit

algebra. 28 students were in the experimental group which was taught with social constructivist approach whereas 26 were in the control group which was taught with traditional techniques. Same instrument were administered as pre and post- test. The test had 10 items with selection and supply type questions. To explore the difference between two groups t- test analysis were conducted. Result that was revealed from the pre- test analysis showed that, there was no significant difference between two groups. On the other hand according to the post test results treatment group which was taught with the social constructivist approach showed significantly higher learning outcomes in terms of knowledge and understanding when it was compared with the control group that was taught by traditional techniques. Moreover it was stated that Vygotsky' s social constructivist approach lead students to interact with each other and share ideas in addition to listening others' point of view. Development of social interaction, communication skills and learning collaboratively in a friendly environment were all established by the approach.

As it can be seen from the studies that were about social constructivism, it has positive impacts on the understanding of the concepts. In addition it is also beneficial to create a context that results with conceptual change by increasing interaction between peers and teaching students listen to others' point of view. Dilemma creation and solution can be done in such an environment within small groups. Moreover sharing ideas and social interaction were also important aspects of social constructivism that results with understanding. Such friendly environment that is constructed by social constructivism would increase students' motivation towards biology learning (Williams, 2011). Watters & Ginns (2000) revealed a result in concordance with the fact that social constructivism creates an increase in students' motivation mainly by increasing self- efficacy. It could also change the type of achievement goal that students have by supporting autonomy Hanrahan (1998). It is a known fact that by social constructivism (Morrone, Harkness, D'Ambrosio & Caulfied, 2004) students may increase their mastery goals for the subject. Summers (2006) stated that students who do not meet their caring needs or do not have a best friendship have higher tendency to have performance goals. On the other hand such a

friendly environment that is constructed by social constructivism may have a chance to eliminate such reasons to have performance goals.

2.3 Computer Animations

It is a known fact that in some topics such as molecular genetics instruction, researchers who have implemented constructivist approach advised the integration of modeling and visualization to the instruction (Gilbert, Justi & Aksela, 2003). According to Weiss, Knowlton & Morrison (2002) animations are pictures in motion and analogous to a subset of visual graphics. Their dynamic features provide change in figures or colors, emergence and extinction of some situations in realization process of the events (Daşdemir, Doymuş, Şimşek & Karaçöp, 2008). Within a computer based instruction environment its usage would enhance instructional and learning processes. Usage of computer animation may increase conceptual understanding by enhancing formation of dynamic mental models. For explaining particular nature of matter in submicroscopic processes, animations create correct visual models (Williamson & Abraham, 1995). Such submicroscopic concepts can be observed mainly in the topics of meiosis, spermatogenesis and oogenesis. Moreover dynamic mental models are needed in human reproduction mainly in the topics which creates misconceptions due to being dynamic processes such as the menstrual cycle and hormonal control. They are static and dynamic representations serve as language tool when words and gestures were not enough Trindade, Fiolhais & Almedia (2002). As cited in the study of Rotbain, Marbach- Ad & Stavy (2007), Gordin and Pea (1995) revealed usage of computer animation advantageous in terms of representing the concept as a sequence. It has a chance to add temporal component and manipulation of data sets. The study also revealed that computer animations help students to demonstrate processes in a way to model students how to connect between things. In the study of Lin (2011), it is stated as verbal and nonverbal memory modes are two interdenpendent types of memory mode to process and store information. As cited from Paivio (1990), animations which are coding pictures in

both verbal and nonverbal forms would increase efficiency of the instruction. Their usage is also important to have an advantage on its beneficial features. Active learning is advised by the researchers to increase efficiency of the computer animations.

According to Lin (2011) by providing feedbacks in different forms, animation are both entertaining and motivating learners to accomplish correct responses. As cited from Rieber (2000) they can increase students' attention easily. Ayres & Paas (2007) stated that students' attention directed to relevant visual information by attention cueing and embedded animated pedagogical agents within the animations. In addition to being attention gaining and entertaining they were believed to increase students' motivation towards learning (Lin, 2011; Windschitl, 1998). Results of the study of Kim (2006) revealed that in both 2D and 3D simulations a positive change in the attitude toward science has been seen. Daşdemir, Doymuş, Şimşek & Karaçöp (2008) stated taking attention, providing motivation, having over knowledge and providing the classification of complex information and events as some of the benefits of animations.

One of the studies conducted about usage of computer animation in an interactive way to deal with abstract concepts and processes in molecular biology were done by Rotbain, Marbach- Ad & Stavy (2007). Subject of the study was 17 and 18 year old students. There were two groups which were experimental and control group. Within experimental group there were 61 students from five classes and in control group there were 116 students from eight classes. Activity booklet used to create an interactive working environment for the experimental group. To increase benefits of the computer animation interactive usage is essential. To create that active environment in addition to hands- on activities, also minds- on activities must be applied. Students mainly worked alone but they were also encouraged to discuss the materials with pairs in order to enhance cooperative learning. During treatment computer animation was used to simulate structure of DNA and RNA, DNA

replication and protein synthesis, which were all abstract and submicroscopic concepts and processes. In the control group traditional techniques were used. For both groups treatment took twelve hours. In addition computer animation activity took four hours. As measurement instrument multiple choice written questionnaire and semi- structured questionnaire were used which was administered right after the molecular genetics instruction. Before administration researcher conducted interviews with students about their experience during instruction and about the model's contributed to their learning. According to the results of the t- test there were no significant differences in the pretest results. Study was also revealed that achievement of the experimental group was significantly higher than the control group according to the t- test analysis. It was stated that computer animation increased student understanding by accurate and rich picture of dynamic nature of the submicroscopic processes. Teachers' perspective according to the study was that computer animations helped them to teach abstract concepts in a concrete way. It also created an opportunity to circulate between students and perceive their learning processes in a better way. It helped students by giving immediate feedback. Overall by the help of the method teacher could pay attention to individual students who needed help in a more effective way, which is something important in social constructivism in terms of providing scaffolding. Also some teachers revealed that computer animation helped them reach into deeper understanding of the translation mechanism as well.

Another research conducted about usage of computer animation was done by Lin (2011) on the topic physiology of the human heart. Aim of the study was to search for the effect of different types of visuals which were both static and animated in addition to the instructional strategies such as usage of questioning, usage of questioning in addition to giving feedback and instruction with no strategy on students' learning objectives. All those feedbacks and questions were established within the computational module. Sample of the study composed of 582 undergraduate students within the eastern university in the United States. Students were from a number of classes and with different majored disciplines like education,

engineering, physics, statistics, etc. Moreover 324 of the participants were female whereas 258 were male. Study was conducted with 2 x 3 factorial experimental design. There were two independent variables which were visual type and instructional strategy type. 291 of the students were grouped under static visuals and the other 291 were grouped under animated visuals. Each two groups were divided into three with 97 subjects for creating groups with no strategy, questions and questions with feedback. At the end of treatment the four criterion posttest with 80 items was administered to measure differences in the students' understanding of the materials for six groups. Four criterion test was developed by Dwyer (1972) to asses students' understanding and achievement. Facts, concepts, procedure/ rules, comprehension and problem solving were some of the learning outcomes that were measured. Each criterion test was composed of 20 items. There were drawing test, terminology test, identification and comprehension tests with 20 multiple choice questions. Two different analyses were conducted. Frist analyses were for all items in the criterion posttest. Second one was about analysis of 34 enhanced items which were composed of nine drawing test, twelve terminology test and thirteen comprehension test items that were identified in the pilot study as difficult. According to the result of the study students who were in the group which treated by animation scored significantly higher on all criterion posttest in two analysis with respect to students who were treated by static visuals. In addition students who received questions in addition to feedback and who received only questions scored significantly higher scores than the students who received no strategy on terminology and comprehension test. This is something parallel with social constructivism, since prompting by the help of questioning and giving immediate feedback during scaffolding are important aspects.

Daşdemir, Doymuş, Şimşek & Karaçöp (2008) also conducted a study about the effects of computer animation while teaching acids and basis. Subject of the study were 55 students from different classes of the eight grade of a primary school in the Erzurum. There were two groups which were named as animation group and control group. In the animation group, which was composed of 26 students, animation

technique was used whereas in the control group, which was composed of 29 students, teacher centered traditional technique was used. Within both groups after the instruction same course materials that were prepared based on the source book was applied. Science and Technology Achievement Test with 16 multiple choice items and Students Opinion Scale Test were the two instruments that were used. During the research Achievement Test was used as pretest and posttest whereas Students Opinion Test used only as posttest. Independent sample t test was applied for the analysis of achievement test whereas analysis of percentages and arithmetic means were considered for analyzing opinion test. According to the results computer supported animations create significantly higher levels of achievement when it was compared with the control group. It was stated that animation oriented instruction both increased achievement level in addition to retention of knowledge. Moreover according to the Student Opinion Test it was revealed that students like animations. They figured out that animations were perceived as informative, easy to understand, beneficial, instructive enjoyable and creative by the students.

According to the findings of these studies it was clear that computer animations have positive impacts both on the students understanding of concepts and level of motivation. It is also a known fact that they can enhance constructivist instruction by helping visualization (Gilbert, Justi & Aksela, 2003). By having an effect on students intrinsic values, like stating the environment enjoyable (Daşdemir, Doymuş, Şimşek & Karaçöp, 2008), they can also effect the type of achievement goals that students choose. It is also important to focus on how they were implemented to instruction (Rotbain, Marbach- Ad & Stavy, 2007). Designing an active learning environment is important to increase efficiency of the computer animation, which is the main aim of the computer animation and physical modeling implemented social constructivist approach.

2.4 Physical Modeling

Physical modeling is one of the other ways that is used to create a conceptual change especially in the meiosis topic. As stated before in some topics such as molecular genetics instruction, researchers who have implemented constructivist approach advised the integration of modeling and visualization to the instruction (Gilbert, Justi & Aksela, 2003). A physical model is used in various contexts to mean a physical representation of something. That thing may be a single item or object (for example, a bolt) or a large system (Angeli & Valanides, 2004). They serve as concrete materials that represent abstract and complex subjects of science (Sarıkaya, Selvi & Doğan Bora, 2004). Therefore in the case of models and modeling in science education, models are used as the source analog, which then act as an instructional tool in reasoning about the target analog and for understanding a new concept (Rotbain, Marbach-Ad & Stavy, 2006). Abstract concepts that were tried to be visualized without any representation make students memorize the concept. On the other hand in such cases usage of posters and physical models easies the visualization (Lock, 1997). Clark & Mathis (2000) stated that in biology physical modeling as a hands on activity can be beneficial as a tool for teaching molecular structure and functioning of those structures.

Sarıkaya, Selvi & Doğan Bora (2004) conducted a study about the effect of usage of physical modeling on teaching mitosis and meiosis in terms of academic success. 56 students were the subject of the study who was ninth graders in Balgat Anadolu Teknik Lisesi. There were two groups which were experimental and control groups. 32 students attained to experimental group whereas 24 students were in the control group. In the experimental group mainly traditional teaching methods were applied. That technique was enhanced by the usage of physical modeling. For constructing physical models students were grouped in four. On the other hand control group was taught with traditional techniques. As measurement instrument achievement test which was developed by the researcher was applied. The test was composed of 15

multiple choice items. Cronbach alpha of the test that was figured in the pilot study was 0, 76. For analysis t- test analysis was used. According to the results there was a significant difference in terms of academic success of the students in the favor of the experimental group. This difference explained by usage of physical modeling since it makes abstract concepts concrete. Also by making students construct a model active learning environment was created.

In the study of Brown (1990) again physical modeling of meiosis activity is used. 100 subjects were used in the study from pre- university and university level in Cambridge. According to the results 52, 9 percent of the subjects accomplish to show duplication of chromosomes into chromatids, 16 percent complete to show sister chromatids carry the same allele and 22. 8 of them did not have any problem in the concepts "heterozygote" and "locus". Therefore the study may open a path for school teachers in terms of showing the effectiveness of the instructional methods and the implementation in the lessons. Moreover the study will also have important impacts on the education field in terms of comparing two instructional methods, and may lead to a wider comparison with different grade levels and different topics.

One of the other studies about physical modeling is the study of the Rotbain, Marbach-Ad & Stavy (2006). In the study three comparable groups of eleventh and twelve grade students were the participants from Israeli urban and suburban schools. The control group was composed of 116 students and instructed in the traditional lecture format. The experimental groups received both instructions designed on physical modeling and illustration models. The group exposed to physical modeling was composed of 71 students as well as the group exposed to the illustration models. During the treatment similar instructions and questions are applied in both experimental groups. ANOVA was used to analyze the data that is gathered. The study revealed that the students who have exposed to one of the two types of models have acquired better understanding of knowledge when they were compared with the control group which exposed to the traditional teaching. In addition the results also

showed that the physical modeling activity is significantly more effective than the illustration activity as well.

Another study was conducted about physical modeling in the cell topic was done by Lazarowitz & Naim (2013). Subject of the study included 669 students who were attained to ninth grade. Students were randomly assigned as three comparison group. One group attained to instruction with construction of hands- on three dimensional cell organelles and macromolecule models, the other was teacher demonstration of three dimensional models of the cell structure and the last one was teaching cell topic with regular learning materials such as two dimensional cell structures in charts, textbooks and etc. For analyzing the data MANOVA was used. According to the results of the study group of students which were attained to hands on model building group showed significantly higher mean scores on academic achievement tests. They were better in answering both high and low cognitive questions. Main explanation for the situation is the active engagement of the students.

According to the results of the studies of the Rotbain, Marbach-Ad & Stavy (2006) physical modeling and the computer animations are both beneficial techniques that can be used in instruction. Physical models were tools to demonstrate abstract concepts in a concrete ways. In the study of Lazarowitz & Naim (2013) it can be clearly seen as how it is implemented is vital to enhance its effectiveness. It is important to implement physical models in an active learning environment which will in the end develop students' active learning strategies. Moreover according to the study of Tuan, et al., (2005) creating active learning strategies is an important aspect of motivation as well. In the light of this information computer animation and physical modeling integrated social constructivist approach designed as an active learning environment for both usages of computer animation and physical models. In the literature there is no study which searches for social constructivist approach integrated with computer animation and physical modeling in the understanding of human reproduction as a whole. Moreover its effect on motivation did not search as

well in addition to effects on achievement goal orientation which would definitely be effected since all of the methods have beneficial effects on motivation.

2.5 Motivation

As stated before, motivation was defined as a force that an individual participate to an activity by being internally conditioned (Biehler & Snowman 1997; Elliot, Kratochwill, Littlefield & Travers, 2000; Pintrich & Schunk, 2002). Presence of the behaviors like "choice of tasks, efforts, persistence and verbalizations" identifies motivation (Pintrich & Schunk, 2002, p.5).

Persons' needs for achievement or the locus of control influence his/ her state of motivation. Locus of learning is not just related with individual' s mind but also related with occurrence in a community of participants and its distribution between co- participants (Marshall, 1996; Bredo, 1994). Moreover motivation also affected by one's cognitions about the task at hand, the consequences of task completion and ability to do the task. For ongoing learning processes two points are important to figure out continuing motivation. These are whether learners' expectations about learning and its consequences are met in addition to their attributions of failures and successes (Driscoll, 2005). Individual would like to engage in achievement task when motive for success is high. On the other hand they would avoid achievement task when their motive for avoiding failure is high (Credler, 2005). Therefore their satisfying expectancies, attributions and self- regulation skills are important to overcome difficulties and sustain their motivation (Driscoll, 2005).

Locus of control of the individual is another important aspect of the motivation. Rotter (1966) states that internal and external locus of control determine how causes of the behavior perceived. Students who perceive positive reinforcement as a

consequence of his/ her hard work or planning are inner- directed and take responsibility for the events in their lives. In contradiction there is no relationship between behavior and reinforcement according to the outer- directed individuals. Therefore any failure in the exam perceived as lack of ability for the inner- directed individuals whereas result of bias for the outer- directed individuals.

Desires of the individual that directs their behavior motivation can be classified into two as intrinsic and extrinsic motivation. According to Fetsco & McClure (2005) when students creates a relationship between their actions and external reward that they received they can be concluded as extrinsically motivated. Whereas motivation generated without any external reward is classified as intrinsic motivation. Internal desire is the reason to accomplish a given task. According to Driscoll (2005) curiosity and interest is one of the aspect of origin and determination of the motivation. Curiosity is a strong motivator of learning and can be stimulated by novel, complex and variety of patterns in the environment (Berlyne, 1965). To sustain curiosity fantasy can be used. Moreover creating a context with inquiry based learning would result with deeper level of curiosity. Goal and goal orientation and self- efficacy are the other important aspects of origin and determination and origin of motivation. Learner's beliefs about themselves in terms of task difficulty and task outcome is the definition of the self-efficacy. According to Bandura (1997) belief system is related with behavior and outcomes. Therefore to achieve desired outcome their judgment about themselves about their ability to perform related task can be stated as self- efficacy. Their outcome expectations are also important aspect of self- efficacy and classified into three as physical effects, social effects and self-evaluative reactions of the individual about students' behavior. Moreover four principals may influence self- efficacy beliefs which are enactive mastery experience which refers to learner's own previous success at task; vicarious experiences which refers to learner's observation of a role model attaining success at a task; verbal persuasion which refers to others persuading a learner that he/ she is capable of succeeding a particular task and lastly physiological state which refers to intrinsic feeling convinces them of probable success or failure.

In the light of these information student's beliefs about motivation shaped by the social world, his/ her perception about the social experiences, environment, student's aptitudes and prior- achievement related factors (Credler, 2005). Moreover self-efficacy, goal orientation, attitude, prior knowledge, reasoning ability, learning approaches and epistemology also determine motivation of an individual (Kizilgunes, Tekkaya & Sungur, 2009).

Theories related with motivation can be classified into two as behavioral and cognitive theories as well. According to Driscoll (2005, pg. 312) intrinsic motivation is emphasized by social cognitive theory, since people are active and curious learner's that are seeking for information for a related problem. Reinforcements and punishments are less important than influence of social model for the social cognitive theory on learning and behavior (Pintrich & Schunk, 2002). Behavioral theory on the other hand assume motivation as a change in the rate, frequency of occurrence, or form of behavior (response) as a function of environmental events and stimuli (Pintrich & Schunk, 2002). Observable behavior is considered as motivation, thoughts and feelings don't have any contribution to motivation. Therefore students are motivated by environmental stimuli which make arrangement of the environmental context important for the teaching purposes.

One of the studies related with constructivism and integrated representatives were conducted by Choi & Johnson (2005). Aim of the study was to search for the effect of constructivist approach integrated with context- based video instruction on students' learning and motivation. For creating context- based video instruction creation of active learning environment was the main concern. To create such an environment instruction based on constructivism for engaging learners in active, authentic and collaborative learning was chosen. Sample of the study was composed of 16 students who were attained to master's degree program in a large university in the Midwestern United States. Research was design as a quasi-experimental study with two groups which were experimental and control groups. To measure the effect

comparison of students' perception about the traditional text based instruction, that was applied to control group, and online context based instruction, which was applied to experimental group, was done. For that purposes only posttests were administered as instrument. Two Likert- scaled questionnaires and one open ended questionnaire was applied. According to the results of the study there was a significant difference in students' level motivation mainly in terms of the level of attention they have. Motivation was analyzed with sub categories that were attention, relevance, confidence and satisfaction. For collecting data Likert- scaled questionnaires were administered and analyzed with paired *t* test. For the relevance and satisfaction subcategories there were no significant differences between two groups. Major difference between to instructional strategies was shown with the attention subcategory in addition there was a significance difference in the overall motivation scores of the students in the favor of the experimental group. It was also revealed that video based instruction created longer retention and understanding level than the traditional method. To analyze understanding level Likert- scaled questionnaires were used and data was analyzed with *t* test analysis. For the measuring retention level data was collected by open ended questions and analyzed by reflective analysis.

Another study was conducted by Campregher (2011) about constructivist approach and cooperative learning methodology integrated with Interactive White Board. Main purpose of the study was to investigate effect of the approach on learning process, learning styles as well as students' motivation. There were two groups which were experimental group and control group. In the experimental group activities with Cooperative Learning using the Interactive White Board was applied. On the other hand in the control group activities with cooperative learning were applied without any usage of Interactive White Board by students but the teacher. Instruction was applied for seven months. Subject of the study was two fifth grade classes of a primary school in Trentino, Italy. Both pretests and posttests were applied. As quantitative measurement questionnaires, learning tests and maintenance learning tests were applied. Researcher diary record, video recordings, teacher structured

observations, students qualitative questionnaire and circle time were the qualitative measurements. Active usage of Interactive White Board within constructivist approach integrated with cooperative learning increases permanence of the knowledge significantly according to the results of the study. Moreover cognitive styles of the students shift towards the style of visual/ verbal in the experimental group. In addition results revealed that there is a significant difference in the students' level of motivation in the favor of the experimental group. This difference was explained by the increase in concentration and positive attitudes towards the school environment. Increase in the attitude towards the school environment and attributes was correlated with the increase in the independency. Therefore it was concluded as constructivist approach with cooperative learning integrated with usage of Interactive White Board by the students improved students' motivation, concentration, independency and attitudes towards the school environment.

Hanrahan (1998) conducted a study about the learning environment of an eleventh grade biology class in local Brisbane high school which was searching for the effect of constructivist approach on students' motivation and learning. Subject of the study composed of 15 students, which twelve of them were girls and three of them were boys. For gathering data participant observation over six weeks (two units of curriculum), interviewing with teacher and a range of students and written response survey (Classroom Environment Survey) were used. According to the results of the study it was found that students view the class positive and described as highly motivated to learn. On the other hand level of cognitive engagement depends on the control of the teacher on the activities and student beliefs about learning in the context. It was also stated that both intrinsic and extrinsic motivation were restricted by teacher- centered methods of instruction. To overcome the situation it was suggested to use activities that reinforces positive beliefs about the self- direction would be beneficial.

In the light of this information it can be concluded that social constructivist approach has an effect on the students' level of motivation. Mainly by increasing the independence and autonomy, students' level of motivation increased (Campregher, 2011). Also it is a known fact that active learning increases the students' level of motivation (Millis, 2012). In the study of Tuan, et al., (2005) effect of inquiry based learning on the students' level of motivation was investigated. Students' motivation towards science learning questionnaire was used to estimate intrinsic motivation level of the students. As a result of the study there is a significance difference in the group which used active learning strategies, treated with inquiry based learning. Moreover as stated before usage of physical models (Lazarowitz & Naim, 2013) and usage of computer animation (Lin, 2011; Windschitl, 1998) increases motivation as well. Therefore it is logical to explore effect of the social constructivist approach integrated with physical modeling and computer animation on the students' level of motivation in addition to understanding of the student in human reproductive system unit. Intrinsic motivation of the students as in the case of Tuan et. al was the main concern of the study. Moreover it is a known fact that intrinsic motivation is positively correlated with mastery approach goal orientation (Nien & Duda, 2008). Also as cited by Dignath, Buettner & Langfeldt (2008), Pintrich (1999) stated that motivation was related with self- regulation. So same method expected to have an effect on the type of achievement goal orientation that the students have which was an important aspect of self- regulation.

2.6 Achievement Goal Orientation

In the recent years self regulation is one of the most popular topics of the research in education area. There are different definitions for self regulation from different researchers. One of the most known definitions is, being able to develop knowledge, skills and attitudes which can be transferred from one learning context to another and from learning situations in which this information has been acquired to leisure and work context (Boekaerts, 1999, p. 446). It is also defined as an active, constructive

process whereby learners set goals for their learning and attempt to monitor, regulate, and control their cognition, motivation, and behavior guided and constrained by their goals and contextual features in the environment (Pintrich, 2000).

As it can be understood from the differences in the definitions of the self regulation, there are different models that are generated by different researchers to explain the self- regulation. For instance Boekaerts (1999) developed the three layered model for self- regulated learning. According to this model the inner layer of self- regulated learning is "regulation of processing modes and choice of cognitive strategies". Then comes the "regulation of learning process" and "use of metacognitive knowledge and skills to direct one's own learning". Lastly "regulation of the self" and "choice of goals and resources" makes the outer layer of the model. Another different model for self- regulation is made by Zimmerman (2000) as cyclical phases of self regulation. According to this model self regulation has three phases. The first phase is the forethought phase that includes goal setting, strategic planning, self- efficacy, outcome expectation, intrinsic interest/ value and goal orientation. Second phase is the performance/ volitional control phase that has self-instruction, imagery, attention focusing, task strategies, self- recording and self- experimentation under it as its' components. Lastly self- reaction is shown as the last phase of the self- regulation that includes self- evaluation, causal attribution, self- satisfaction/ affect and adaptive- defensive.

Even from these two models that are generated by different researchers it can be clearly seen that goal orientation is shown as the one of the important aspect of the self- regulation. As stated before it is also known that setting specific and difficult goals stimulate self- regulation (Winnie, 1995).

According to the meta- analysis of Kaplan & Maehr (2007) goal orientations are part of the cognitive life of the individual. It is known that in most of the studies about

goal orientation two perspectives are considered. The first one is that goal orientations assumed as emerging from schemas of achievement situations whereas the second perspective basing on goal orientation to achievement- related self-schemas. According to them basing on goal orientation to schemas implies "the concept of purpose that is activated by in response to a set of circumstances" (Kaplan & Maehr, 2007, p. 155). In addition it also implies that there is a script that guides the action. Therefore in a way "goal orientations are pathways to filter the information, construct and appraise the nature of situation, create meaning and guide action" (Kaplan & Maehr, 2007, p. 155).

According to the finding of Winnie (1995) it can be concluded that goal orientations can be differentiated. There are numerous differentiation has been done by different researchers (Deci & Ryan, 2000; Middleton & Midgley, 1997). For instance Boekaerts (1999) classified goals as personal goals and ought goals. According to him learning activities that are self- initiated are regulated by personal goals. On the other hand activities that are done for others are regulated by ought goals. Furthermore he stresses that most of the time rather than having single goals students regulate themselves by multiple goals. In addition to the study of Boekaerts (1999), Palmer (2005) classified sutdents' personal goals as social goals, mastery goals and performance goals. For that aspect social goals represents students' will to gain approval of teachers and peers whereas performance goals represents students' will to demonstrate their ability to others by getting high marks or even higher marks. Pintrich defined main aim of performance goals as trying to outperform or best others using normative standards (Pintrich, 2000). Extrinsic, ability approach, ability focused, relative ability and ego are the alternatives that can be used as performance goals according to the Carpenter (2007). In contrasts whit the performance goals mastery goals represents students' will to master the work, which makes it the most beneficial type of goal orientation since it activates the use of deep learning strategies and performance (Anderman & Maehr, 1994; Pintrich, 2000). Students with mastery goals value their experience and the amount of learning, understanding, interest rather than the marks he/ she gets (Carpenter, 2007; Pintrich 2000). Ames & Archer

(1987) defines aim of mastery goals as the progress in the competence. Rather than using mastery goals task involved goals, intrinsic goal, learning goal and task-focused goals can be used as well (Carpenter, 2007). Pintrich (2000) also classified achievement goal orientation as approach and avoidance focuses. If a student have approach focus achievement goal orientation he/ she should have positive relations with cognition, motivation and behavior, which is the contrary situation for the avoidance focused achievement goal orientation.

There are other point of views which mixes up two types of classification of achievement goal orientation which are approach/avoidance and mastery/performance. In the study of Elliot (1999) achievement goal orientations grouped in a trichotomous way as performance- approach goal, performance-avoidance goal and mastery goal orientation. The students that have each of these goal orientations can be differed.

First aspect of Elliot's (1999) classification is the performance approach goals. The student that has performance- approach goal orientation can be summarized as a student that has aim to get better grade, present better ability, do better than others and demonstrate his/ her ability to others (Elliot, 1999). Being the best and the smartest is the main concern, therefore students measure their achievement in normative standards like being the best (Pintrich, 2000). According to the study of Elliot (1999) they are motivated even when they thought that they are outperforming. Performance approach goal can also be named as "performance goal", "ego-involved goal", "self-enhancing ego orientation" and "relative ability goal" according to Pintrich (2000). Students with performance approach goals tend to demonstrate positive ability in comparison with others (Palmer, 2005, p. 1858). Therefore it can be stated that performance approach goals are linked with positive outcomes such as persistence, positive affect and grades (Pintrich, 2000).

Second aspect of the trichotomous classification is the performance avoidance goals. Elliot (1999) defines student with performance- avoidance goal orientation as a person that worries about doing bad all the time, therefore they are being motivated by the thought of performing poorly since they are trying to avoid performing poorly. Most of the time they are scared about asking ridicules question because of seeming as a "dumb" person. Pintrich (2000), states that performance avoidance goals focus students to normative standards of preventing being the lowest performer of the class. Those students use minimum amount of effort for avoiding looking incompetent to others (Palmer, 2005). This type of goals are related with negative outcomes such as low self- efficacy, anxiety, avoidance of help-seeking, self-handicapping strategies and low grades (Pintrich, 2000).

According to Palmer (2005), both performance avoidance and performance approach types of goals have negative impacts on motivation since main focus of the student is on other students rather than the content. Even if classroom activities that generates competition and comparison stated as the ones that should be prevented to eliminate negative impacts of performance goals some studies show that students can have multiple goals. For instance in the case of students with both mastery goals and performance approach goals negative impact of those kinds of activities could be diminished (Pintrich, 2000). The type of goal orientation that the student would have depends on different variables. As stated before according to Elliot (1999) competence- based variables (e. g., need for achievement), self- based variables (e.g., self esteem), relationally- based variables (e.g., fear for rejection), demographic variables (e.g., sex), environmental variables (e.g., norm- based evaluation) and neurophysiological predispositions (e.g.,BIS sensitivity) are the factors that influences the types of goals students could have.

Mastery goal orientation is the last aspect of trichotomous classification of achievement goals by Elliot (1999). Students with mastery goal orientation can be summarized as a student that tries to learn as much as possible since his/ her aim is

understanding the content deeply, gaining deeper knowledge, mastering completely. They prefer course material that stimulates their curiosity even though the material is difficult to learn. In addition they like challenges (Elliot, 1999). As stated by Palmer (2005), mastery goals are the ones which are preferred since they enhance deep learning strategies.

Since mastery goals activates deeper learning strategies, it is important to enhance them within the classroom context. As Palmer (2005) cited from Ames (1992) in order to enhance mastery goals, tasks that are applied in the classroom should be meaningful and related with real life. Moreover autonomy of the students in classroom context, participation in decision making and having a choice about the structure of the activities and types of products that he/ she will conduct is important as well. As Kaplan & Maehr (1999) stated collaboration could be used, but it has to be enriched by different activities. Active movement social interaction among students even in the forms without collaborative working is important according to them. Giving regular feedback preferably in the context that leads to private recognition of the students about his/ her efforts is also an important point to enhance mastery goals in classroom (Deemer, 2004; Xiang et al., 2003).

Another type of classification that mixes up approach/avoidance and mastery/ performance goals was done by Pintrich (2000). As stated before Pintrich (2000) divides mastery goals into two and add mastery avoidance and mastery approach goal orientation to the Elliots' classification (1999). Actually "Mastery avoidance focus" is the category that is added to the classification of goals of Elliot (1999) since "mastery goals" in trichotomous classification is similar with the mastery approach goals.

According to Pintrich (2000) mastery approach are the ones related with the mastering task, learning and understanding. These kinds of student focus on self-

improvement, progress, deep understanding of task and learning. The goal can be named as “learning goal”, “task goal”, and “task involved goal” as well.

Avoiding misunderstanding, not learning and not mastering the task are the main components of mastery avoidance goals. In contradiction with mastery approach goals student that have this type of goal focus on not being wrong and not doing it incorrectly. But still his/ her main concern is not normative but related with the task (Pintrich, 2000). There has been little empirical research on an avoidance mastery goal (Pintrich, 2000). Therefore according to him mastery avoidance category is not a clear one theoretically. On the other hand in the study of Nien & Duda (2008) presence of mastery avoidance goals has been proved. Conducted researches on mastery-avoidance goal revealed that it is unrelated with cognitive strategies and grades. In addition it is negatively related with intrinsic motivation whereas positively related with negative emotions like anxiety and worry (Kaplan & Maehr, 2007).

Nien & Duda (2008) shows that 2x2 model of classification of Pintrich (2000) on achievement goal orientation that is composed of performance-avoidance, performance-approach, mastery- avoidance and mastery-approach has existed. In their study they use 450 British male and female athletes as sample. Questionnaire, assessing approach and avoidance achievement goals, perceived sport competence, fear of failure and motivation regulations of the sample is measured in the study that is designed as cross-sectional. The analysis supported the four goal model that is equivalent across gender therefore the model can be used for both genders. In their study they showed that perceived competence is positively correlated with mastery-approach and performance- approach goal, whereas fear of failure is correlated with mastery avoidance, performance-approach and performance- avoidance goal. Furthermore it is shown that mastery-approach goal positively correlated with intrinsic motivation and negatively correlated with amotivation. Mastery- avoidance

focus and performance- avoidance focus are positively correlated with amotivation. Lastly performance- approach is positively correlated with extrinsic motivation.

One of the studies related with social constructivism and achievement goal orientation was conducted by Morrone, Harkness, D'Ambrosio & Caulfield (2004). Aim of the study was to search for the social constructivist approach and its influence on the perception of the mastery goals within the classroom in addition to its effect on problem solving ability and understanding of mathematics. For creating an environment in social constructivist approach, firstly students work in groups to try to solve complex mathematic problems. After completing that task, class, work as a whole and each group reveals their solution for the problem that was assigned that day. To measure that purpose student comments at the end of semester course evaluations and Patterns of Adaptive Learning Scales (PALS) were used. Sample of the study composed of twenty eight elementary education students in a mathematic course in Mathematics for Elementary School Teachers at a large urban university in the Midwest. During the treatment class session was videotaped and transcribed mainly by focusing on the instructor statements during the whole group discussion. For making transcription Observing Patterns of Adaptive Learning instrument was used. According to the results that the study revealed social constructivist teacher perceived as he/ she promote mastery goals by the help of the instructional discourse by supporting students towards higher- order thinking skills. For creating that support scaffolding, press for understanding and higher order thinking skills was applied. It was suggested that within the social constructivist classroom students gather their autonomy or ownership while determining whether their solutions are correct. At the end teacher affect became less important since instructor was not the only one who can judge different solutions. As cited from Turner (2002) to create mastery oriented classrooms emphasizing understanding, student autonomy and positive teacher affect is vital. Moreover de- emphasization of evaluation of students' contributions and direct instruction to reach correct answers must be considered as well. The contradiction about the results related with teacher affect was explained by being in college level rather than elementary or middle school level. It was suggested

that college instructors may truly care about students' contributions and engagement, therefore importance of affective statements decreased.

Summers (2006) conducted a study that was searching for the influence of socioconstructivism, especially peer learning within the classroom on the students' goals which were categorized under social and achievement goals. To enhance peer learning, collaborative learning technique was used. Within the collaborative learning students' shared achievement goals were also investigated. Study was applied in sixth grade nine mathematics classes with the help of two female teachers who were supporting social constructivism. Teachers' point of views about social constructivism was measured by five- point Likert survey, Constructivist Teaching Methods Scale. 200 Students who were attending to a middle school in a midsized southwestern country were the subject of the study. Within the school students from different socio economic background levels can be seen. In order to measure the purpose of the study self- report questionnaires were applied two times within the school year. One two months before the school began and one two months after the school ended. Social Goals Questionnaires developed by Hicks (1996), Patterns of Adaptive Learning Survey that measures academic achievement motivation and developed by Midgley, et al., (1997) and Friendship Quality Questionnaire that was developed by Parker & Asher (1993) were used as questionnaires for first application. In the second application in addition to those listed questionnaires modifications of the shared academic goals survey and shared social goals survey (Summers, Beretvas, Gorin & Svinicki, 2005) were applied as well. According to the results of the study within the more experienced teachers' class, groups which were collectively valued academic goals of the group adopted individual motivational strategies related with performance avoidance goals within time. They value achievement goals of their peer learning groups in addition to valuing opinions of their group members. In such an environment preventing embarrassment would be their first concern. Classroom practices with social constructivist approaches such as social learning and collaboration make students more self-conscious about the others' evaluations which lead to an increase in the performance avoidance goals.

Therefore it can be clearly seen that social constructivism has different impacts on the type of the achievement goals of the students. It can either create an environment that emphasizes mastery goals or an environment that the first concern of the students is to prevent embarrassment. As stated in the study of Anderman & Anderman (1999) students' perceptions of the task and ability goals emphasized in the classroom setting are important on developing students' personal goals. Social perceptions also have a role in tendency of the type of achievement goal orientation that students have. Enhancement of social goals like forming peer relationships and social status increases focus on self whereas focus on the social responsibility goals increase focus on tasks. As Credler (2005) suggested focusing on grades during lecturing or usage of ability games with few winners must be prevented to support mastery oriented goals. Therefore preventing competition is an important aspect. Furthermore Credler (2005) stated that effort, improvement and challenge must be the main concern of the classroom environment. Student participation, which is not focusing on the volunteered students but calling on all students; autonomy by having freedom to talk with others, deciding order in which to compete the tasks; recognition of students effort with focusing on task; teacher encouragement by warm praises and making students believe that they can complete the given task even if they are struggling are the important aspects of classroom settings to lead students towards mastery oriented goals. These are all in concordance with social constructivist approach integrated with computer animation and physical modeling. The necessity of making students reassure that instructor believes they can accomplish the given task is parallel with the findings of the Skaalvik & Skaalvik (2013) which was the positive relation between students' perceptions of their teacher and their learning goals. Also study of Pulkka & Niemivirta (2013) revealed relation between positive evaluations of the learning environement and mastery goals as well.

In the light of this information it can be clearly seen that achievement goal orientation and motivation are both related with each other (Nien & Duda, 2008). As the findings of the study of Dinger, Dickhäuser, Birgit & Ricarda (2013) revelead, students' achievement goals can be used to predict their intrinsic motivation level. It

is also a known fact that different types of instructions such as social constructivist approach have an impact on the students' achievement goal orientations (Morrone, Harkness, D'Ambrosio & Caulfied, 2004; Summers, 2006). In addition to the type of instruction it is important to determine how it is applied within the class (Hanrahan, 1998). It is important to support student autonomy in order to enhance mastery goals within the class which is supported by constructing physical models during the computer animation and physical modeling implemented social constructivist approach. One of the main differences of this study on the other hand is to search for the effect of both physical modeling and computer animation in a social constructivist classroom environment for the human reproductive system unit in the focus of students' tendency towards different types of achievement goal orientations.

CHAPTER 3

PROBLEMS AND HYPOTHESIS

3.1 Main Problem and Sub-problems

3.1.1 Main Problem

1. What is the effect of physical modeling and computer animation implemented with social constructivist instruction compared to traditional instruction on 10^{th} grade students' in terms of creating conceptual understanding about the human reproductive system and their motivation towards biology learning?

2. What is the effect of physical modeling and computer animation implemented with social constructivist instruction compared to traditional instruction on 10^{th} grade students' tendency towards different types of achievement goal orientation?

3.1.2 The Sub-Problems

1.1. Is there a significant mean difference between the groups exposed to physical modeling and computer animation implemented with social constructivist instruction and traditionally designed biology instruction with respect to students' conceptual understanding of human reproductive system?

1.2. Is there a significant mean difference between the groups exposed to physical modeling and computer animation implemented with social constructivist instruction and traditionally designed biology instruction with respect to students' motivation towards biology learning?

2.1. Is there a significant mean difference between the groups exposed to physical modeling and computer animation implemented with social constructivist instruction and traditionally designed biology instruction with respect to students' tendency to have mastery approach goal orientation when their tendency for the goal before the treatment controlled as a covariate?

2.2. Is there a significant mean difference between the groups exposed to physical modeling and computer animation implemented with social constructivist instruction and traditionally designed biology instruction with respect to students' tendency to have mastery avoidance goal orientation when their tendency for the goal before the treatment controlled as a covariate?

2.3. Is there a significant mean difference between the groups exposed to physical modeling and computer animation implemented with social constructivist instruction and traditionally designed biology instruction with respect to students'

tendency to have performance approach goal orientation when their tendency for the goal before the treatment controlled as a covariate?

2.4. Is there a significant mean difference between the groups exposed to physical modeling and computer animation implemented with social constructivist instruction and traditionally designed biology instruction with respect to students' tendency to have performance avoidance goal orientation when their tendency for the goal before the treatment controlled as a covariate?

3.2 Hypotheses

$H_0$1: There is no statistically significant mean difference between post-test mean scores of students taught with the instruction based of social constructivist approach with physical modeling and computer animation implementation and students taught with traditionally designed biology instruction in students' conceptual understanding of human reproductive system.

$H_0$2: There is no statistically significant mean difference between post-test mean scores of students taught with the instruction based of social constructivist approach with physical modeling and computer animation implementation and students taught with traditionally designed biology instruction in students' motivation towards biology lesson.

$H_0$3: There is no statistically significant mean difference between post-test mean scores of students taught with the instruction based of social constructivist approach with physical modeling and computer animation implementation and students taught with traditionally designed biology instruction in students' tendency to have mastery

approach goal orientation when their tendency for the goal before the treatment controlled as a covariate.

$H_0$4: There is no statistically significant mean difference between post-test mean scores of students taught with the instruction based of social constructivist approach with physical modeling and computer animation implementation and students taught with traditionally designed biology instruction in students' tendency to have mastery avoidance goal orientation when their tendency for the goal before the treatment controlled as a covariate.

$H_0$5: There is no statistically significant mean difference between post-test mean scores of students taught with the instruction based of social constructivist approach with physical modeling and computer animation implementation and students taught with traditionally designed biology instruction in students' tendency to have performance approach goal orientation when their tendency for the goal before the treatment controlled as a covariate.

$H_0$6: There is no statistically significant mean difference between post-test mean scores of students taught with the instruction based of social constructivist approach with physical modeling and computer animation implementation and students taught with traditionally designed biology instruction in students' tendency to have performance avoidance goal orientation when their tendency for the goal before the treatment controlled as a covariate.

CHAPTER 4

DESIGN OF THE STUDY

In this part sample of the study, instruments that were used in the study, the description of the treatments and the expression of methods to analyze the data, will be explained.

4.1 The Experimental Design

In this study the quasi- experimental design was used. The Table 4.1 will show the research design of the study.

Table 4.1 Research Design of the Study

Groups	Before Treatment	Treatment	After Treatment
EG	HRSCT	PMCAII	HRSCT
	SMTBL		SMTBL
	SPST		AGQ
	AGQ		
CG	HRSCT	TDI	HRSCT
	SMTBL		SMTBL
	SPST		AGQ
	AGQ		

In the table the EG represents the experimental group that is instructed with the physical modeling and computer animation implemented with social constructivist instruction (PMCAII). Control group is represented by the CG and instructed by traditionally designed instruction (TDI). Same pre-tests were applied in both groups which are Human Reproductive System Conceptual Test, Student Motivation towards Biology Learning Questionnaire, Scientific Processing Skills Test and Achievement Goal Questionnaire. They were represented as HRSCT, SMTBL, SPST and AGQ with respectively. Post- tests that were applied are again same for CG and EG, which were HRSCT, SMTBL and AGQ. Two instructional methods were used one for the CG and one for the EG.

In the study the HRSCT was administered to the both experimental group and the control group before the instruction. The aim of this administration was to determine whether there was a significant mean difference between groups that is caused by their academic performances and pre- knowledge's.

In addition after the instruction the HRSCT was administered again in terms of determining the effects of computer animated and physical modeling integrated social constructivist instruction on students' understanding in the topic of human reproduction.

Other test that was used was SMTBL questionnaire. It was both applied as pre and posttest for both of the groups. Main aim for administrating before the treatment was to figure out whether there was any significant difference between two groups in terms of their motivation level towards biology. However aim for the second administration as posttest was to figure out the effect of computer animated and physical modeling integrated social constructivist instruction on the students' motivation level towards biology lesson.

One of the other tests that were applied is SPST. It was applied as a pretest for both experimental group and control group. Aim of the administration was to figure out whether there was any difference between the students' scientific processing skills before the treatment.

Lastly AGQ was applied both experimental and the control groups. The aim of administration before the treatment was to search for the students beginning achievement goal orientation types. In addition after the treatment the test administered again to understand change in the students' tendency to have different achievement goal orientation that is effected by the computer animated and physical modeling integrated social constructivist instruction.

4.2 Subjects of the Study

Target population of the study was the all the tenth grade students in Ankara. Accessible population of the study was all the tenth grade students attending to Private High Schools in Ankara. The subject of the study was consisted of 125 tenth grade students in a Private High School in Ankara, Çankaya region. The school had high facility equipment in itself. Most of the teachers in the school apply the traditional method in general. In science lessons laboratory sections are also used. The two instructional methods were randomly delivered to the experimental groups and the control groups. The number of students in experimental group was 52 and 73 for the control group. Groups were intact groups. The classes were used in the experiment determined beforehand. The mean age of the students in EG and CG are 15 and 15.33 with respectively. The demographic information of the groups that indicates the previous year's biology grade and the age were shown in the table 4.2.

Table 4.2 Sample Characteristics

	Age	Previous years biology grade (out of 5)
EG	15	4.58
CG	15,33	4.17

The information about sample characteristics was also used during the creation of the subgroups that will be created within the classes.

4.3 Variables

4.3.1 Independent Variables

The independent variables of the study were the treatments, which were physical modeling and computational animation integrated social constructivist instruction and traditional instruction.

4.3.2 Dependent Variables

One of the dependent variable in this study was the understanding of human reproductive system measured by Human Reproductive System Conceptual Test. It was assumed that results could differ according to the type of the treatment. The other dependent variable was the level of motivation towards biology learning. SMTBL was applied again before and after the treatment. So it was assumed that level of motivation could be change again according to the type of motivation. Tendency towards different types of achievement goal orientation was the other dependent variable which can be affected by the type of instruction. AGQ was used as pre and post- test before and after the treatment.

4.4 Instruments

4.4.1 Human Reproductive System Conceptual Test (HRSCT)

Test was developed by the researcher. 16 Items were gathered from HRAT of Saral (2008) related with the anatomy of the reproductive systems in females and males, the sperm and ovum formation, fertilization and hormonal control of reproductive system in males and females. 10 of the items that were developed by the researcher were about meiosis and gametogenesis. There were in total 26 multiple choice questions that assessed the higher order thinking skills, in addition to assessing the misconceptions of the students. Each of the correct answer assumed as one point therefore students' answers were assessed over 26 points.

During the development steps of the test, the objectives were gathered from the national curriculum in addition to the related text books as well. Also misconceptions related with the meiosis and human reproductive system was considered by considering both literature and biology teachers opinion (Veiga, et al., 2006; Saral, 2008; Dikmenli, 2010; Hackling & Treagust, 1982; Goldman & Goldman, 1982). The test covered the topics that were related with the chromosomal movements, the result of the division and the reasons of the division of meiosis in addition to the anatomy of the reproductive systems in females and males, the sperm and ovum formation, fertilization and hormonal control of reproductive system in males and females.

The items of the test were examined by group of experts that was composed of biology teacher, biological science and biology education staffs to assess the content validity. In addition in order to get reliable results, pilot study was done in a Private High school in Çankaya region to a number of 81 tenth grade students.

The reliability coefficient of the test that was gathered from this pilot study is 0.7695 which is appropriate to assume the test as reliable. Test was given students in both control and experimental group before and after the treatment. Students' answers in the test were assessed over 26 points as each correct answer was marked as 1 point (See Appendix A).

The final version of the test was administered to the experimental group in addition to the control group as well to measure their misconceptions before and after the treatment. The items assessed the higher order thinking skills in addition to assessing the misconceptions of the students.

4.4.2 Student Motivation towards Biology Learning Questionnaire (SMTBL)

The instrument was developed by Tuan, et al., (2005) to measure motivational states of the students on learning science (SMTSL). It was translated into Turkish and adapted to biology by Başer (2007) as Student Motivation Towards Biology Learning (SMTBL). Original questionnaire has 35 items with the format of five-scale Likert type. Range of the scale is from "strongly disagree" to "strongly agree". Those items can be categorized under six subscales. Those sub- scales are self- efficacy (SE), active learning strategies (ALS), science learning value (SLV), performance goal (PG), achievement goal (AG) and learning environment stimulation (LES). Alpha value for the entire questionnaire is 0.89 in addition to ranging between .70-.89 for the sub- scales, which shows the internal consistency (Tuan, et al., 2005).

Başer (2007) adapted the test to biology in addition to translation. Two administrations were done as pilot studies. In the first pilot testing there were 214 students. According to the factor analysis results of the first pilot study test was

revised. In the second pilot study there were 137 students. In both of the studies item 14.30 and 34 included in different subscales rather than the subscales they fit in the original questionnaire. Other than these items all the other items fitted correctly. Therefore those three items were eliminated.

SMTBL questionnaire composed of 32 items (see Appendix B). Reliability of the subscales were .85 for SE, .81 for ALS, .84 for BLV, .68 for PG, .72 for AG and .71 for LES. There are 7 items for SE, 7 for ALS, 5 for BLV, 4 for PG, 5 for AG and 4 for LES.

In order to investigate results by considering the subscales, factor analysis conducted for the questionnaire in our study as well. Initial factor extraction presented in the Table 4.3.

Table 4.3 Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.692	30.287	30.287	9.692	30.287	30.287
2	3.199	9.995	40.283	3.199	9.995	40.283
3	2.718	8.493	48.775	2.718	8.493	48.775
4	1.920	5.999	54.774	1.920	5.999	54.774
5	1.573	4.915	59.689	1.573	4.915	59.689
6	1.246	3.894	63.583	1.246	3.894	63.583
7	1.036	3.239	66.822	1.036	3.239	66.822

Table 4.3 (continued)

8	.975	3.047	69.869
9	.816	2.550	72.419
10	.795	2.483	74.902
11	.740	2.313	77.216
12	.728	2.274	79.490
13	.641	2.004	81.494
14	.577	1.805	83.299
15	.564	1.761	85.060
16	.494	1.544	86.604
17	.473	1.479	88.083
18	.418	1.307	89.390
19	.392	1.225	90.615
20	.359	1.121	91.736
21	.340	1.064	92.799
22	.336	1.050	93.850
23	.296	.926	94.775
24	.263	.822	95.597
25	.245	.765	96.363
26	.227	.709	97.071
27	.204	.639	97.710
28	.187	.586	98.296
29	.162	.507	98.803
30	.145	.453	99.256
31	.124	.388	99.645
32	.114	.355	100.000

Extraction Method: Principal Component Analysis.

As it can be seen from Table 4.3, eight components had Eigen values greater than one and 66.82% of the variance were explained by these seven factors. In addition to the factor extraction statistics, screeplot was used to decide the number of the factors that would be extracted. As it can be seen from the Figure 4.1 which presents the screeplot for the eigenvalues, six factors decided for the analysis which explains 63.58% of the variance.

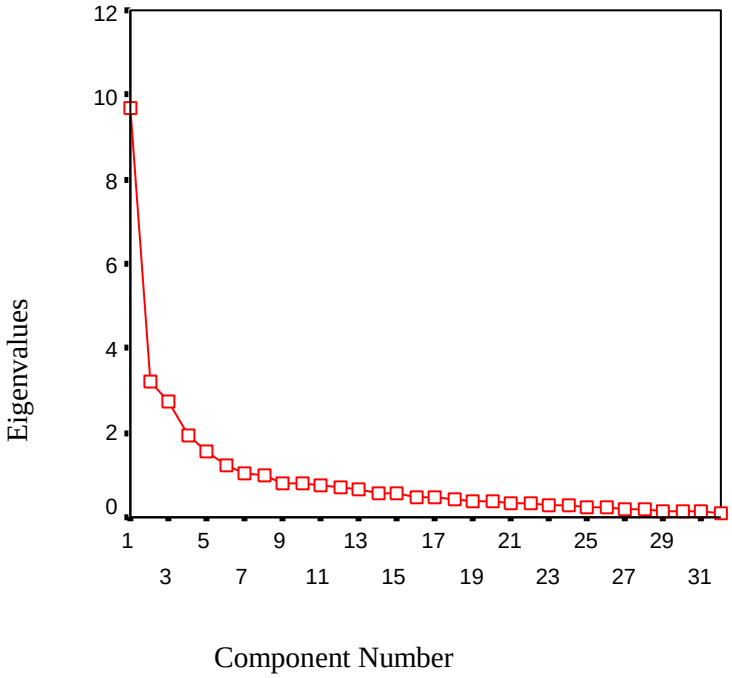


Figure 4.1 Screeplot for Eigenvalues

Table 4.4 presents the result of the rotated component matrix showing the loadings of each item in these components. As it can be seen from the table, results were inconcordance with the literature. All items fit into their components. Termed self- efficacy (SE), active learning strategies (ALS), biology learning

value (BLV), performance goal (PG), achievement goal (AG) and learning environment stimulation (LES) are the six subscales in the questionnaire.

Table 4.4 Rotated component matrix

	Component					
Item	SE	ALS	BLV	PG	AG	LES
1	**.602**	.444	.270	-.078	.130	-.076
2	**.675**	.330	.113	-.060	.151	.026
3	**.597**	.294	.341	-.130	.178	-.033
4	**.720**	.517	.013	-.094	.080	-.145
5	**.734**	.029	.244	-.221	.043	.052
6	**.738**	.106	.271	-.292	-.012	.134
7	**.807**	.291	.091	.045	-.061	.058
8	.475	**.602**	.190	-.078	.075	-.055
9	.185	**.680**	.216	-.027	.196	.030
10	.264	**.523**	.360	-.127	-.015	.141
11	.219	**.606**	.185	-.155	.036	.129
12	.266	**.715**	.148	-.064	.121	.032
13	.163	**.745**	.188	.004	.074	-.068
14	.201	**.824**	.155	.002	.047	-.001
15	.290	.333	**.509**	.078	.314	.093
16	.256	.238	**.721**	.026	.169	.056
17	.166	.288	**.695**	-.130	.152	-.101
18	.387	.269	**.684**	.088	.049	.025
19	.433	.229	**.481**	.061	.044	-.088

Table 4.4 (continued)

20	-.101	-.047	.173	**.785**	-.048	-.110
21	-.163	-.002	.063	**.858**	.060	-.051
22	-.056	.006	-.155	**.793**	-.100	-.082
23	-.146	-.251	-.106	**.666**	.090	-.033
24	.073	.050	.069	.170	**.742**	.008
25	.213	.226	-.025	.055	**.740**	.020
26	-.059	.083	.157	-.230	**.702**	-.084
27	.002	.163	.250	.010	**.669**	.125
28	.034	-.310	-.049	-.147	**.565**	.335
29	-.025	.035	.110	-.097	.080	**.829**
30	.067	.004	-.191	.030	-.023	**.674**
31	.172	-.164	.025	-.157	-.048	**.689**
32	-.119	.139	.069	-.061	.163	**.837**

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

a Rotation converged in 6 iterations.

In the questionnaire self- efficacy means the "Students' perception of his/ her ability to accomplish biology tasks successfully" (Başer, 2007), active learning skills stands for the "students' motivation to engage in active learning strategies to construct knowledge while learning biology" (Başer, 2007). "Students' perception of the value of biology learning" is represented by the biology learning value subscale (Başer, 2007). Performance goal subscale is defined as "Students' desire to perceived as able in biology" whereas achievement goal subscale represents their "desire to increase competence in biology tasks" (Başer, 2007). Lastly learning environment simulation defined as "students' motivation to learn biology resulting from teacher generated environment" (Başer, 2007).

4.4.3 Scientific Processing Skills Test (SPST)

The aim of the questionnaire is to measure scientific processing skills of the students with several subsets that focuses on aspects like, intellectual abilities of students related to identifying variables, identifying and stating hypotheses, operationally defining, designing investigations and graphing and interpreting data. As cited in the study of Geban, Aşkar & Özkan (1992), questionnaire was originally developed by Okey, Wise and Burns (1982) with 36 items in it. Translation and adaption of the test into Turkish were done by Geban, Aşkar & Özkan (1992). Reliability coefficient of the test was .85. This test was given to both experimental and control group before and after the treatment. Each correct answer assumed as one point therefore students' answers were assessed over 36 points (See Appendix C).

4.4.4 Achievement Goal Questionnaire (AGQ)

As Finney, et al., (2004) stated the instrument was developed by Elliot and McGregor (2001) to investigate the 2 x 2 achievement goal framework that has been proposed by Elliot (1999) and Pintrich (2000). It has 12 items with the format of seven- scale Likert type. Range of the scale is from "not at all true for me" to "very true of me". It was administered to 180 introductory- level psychology class undergraduate students. Items were systematically selected to measure four subscales that are mastery- approach goal orientation (MA), performance- approach goal orientation (PA), performance- avoidance goal orientation (PAV) and mastery- avoidance goal orientation (MAV). All items loaded above .70 on their primary factor. Moreover secondary loadings of the factors did not exceed .35. Among the four goal orientations correlations were not greater than .40. Reliabilities of the each goal orientation score were greater than .80 (Elliot & McGregor, 2001).

It was translated into Turkish by the researcher. One administration was done as pilot study. In the pilot testing there were 81 students. The reliability coefficient of the questionnaire that was gathered from this pilot study is 0.8203 which is appropriate to assume the test as reliable. According to the factor analysis results of the pilot study all the other items fitted correctly.

AGQ questionnaire composed of 12 items (See Appendix D). Reliability of the subscales were .81 for MA, .74 for MAV, .88 for PA and .52 for PAV. There are 3 items for each of the subscale.

In order to investigate results by considering the subscales, factor analysis conducted for the questionnaire in the pilot study. Initial factor extraction presented in the Table 4.5.

Table 4.5 Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.591	29.927	29.927	3.591	29.927	29.927
2	2.466	20.546	50.473	2.466	20.546	50.473
3	1.734	14.449	64.922	1.734	14.449	64.922
4	1.302	10.853	75.774	1.302	10.853	75.774
5	.677	5.642	81.416			
6	.589	4.909	86.326			
7	.476	3.963	90.289			
8	.321	2.674	92.962			
9	.294	2.447	95.409			
10	.266	2.220	97.629			
11	.168	1.404	99.032			
12	.116	.968	100.000			

Extraction Method: Principal Component Analysis.

As it can be seen from Table 4.5, four components had Eigen values greater than one and 75.77% of the variance were explained by these four factors. In addition to the factor extraction statistics, screeplot was used to decide the number of the factors that would be extracted. As it can be seen from the Figure 4.2 which

presents the screeplot for the eigenvalues, four factors decided for the analysis which explains 75.77% of the variance.

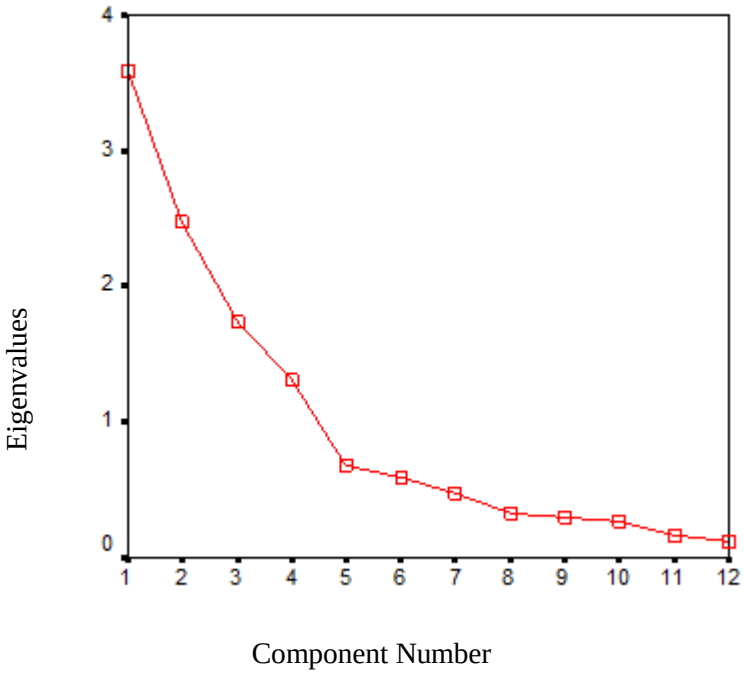


Figure 4.2 Screeplot for Eigenvalues

Table 4.6 presents the result of the rotated component matrix showing the loadings of each item in these components. As it can be seen from the table, results were inconcordance with the literature. All items fit into their components. Mastery- approach goal (MA), Mastery- avoidance goal (MAV), Performance-approach goal (PA), and Performance- avoidance goal (PAV) are the four subscales in the questionnaire.

Table 4.6 Rotated component matrix

	Component			
Item	PA	MAV	MA	PAV
1	**.908**	.110	-.002	.109
2	**.724**	-.056	.165	.113
3	**.842**	.078	.108	.156
4	.382	**.683**	.063	.128
5	.052	**.903**	.036	.088
6	-.146	**.780**	-.037	.161
7	.039	.044	**.931**	.027
8	.129	.066	**.884**	.114
9	.121	-.075	**.920**	-.068
10	.141	.174	.006	**.877**
11	.059	.188	.363	**.665**
12	.217	.057	-.158	**.863**

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

a Rotation converged in 5 iterations.

In the questionnaire Elliot and McGregor (2001) defined competence in different ways according to the type of the orientation. Mastery- approach orientation defines competence in absolute/intrapersonal terms and positively valenced as if to approach success, on the other hand mastery avoidance orientation defines in absolute/ intrapersonal terms and is negatively valenced as if to avoid failure.

Moreover performance- approach goals defines in normative terms and is positively valenced as if to approach success whereas performance avoidance orientation defines as normative terms and negatively valenced as if to avoid failure.

Questionnaire was applied to the students before and after the treatment. Aim was to find out whether instructional treatment affects the tendency of setting different types of goal orientation.

4.5 Treatment (PMCAII, TDI)

This study carried out for four weeks during 2011- 2012 fall semester at a private school in Ankara, Çankaya region. A total of 125 students from six biology classes were the subject of the study. Three teachers were used as instructor. Three of the classes assigned as the experimental group and the other classes as the control group of the study. Experimental group exposed to an instruction with social constructivist approach that was integrated with physical modeling and computational animation. Whereas control group received traditionally designed biology instruction. The topics related to human reproductive system covered as a part of the national curriculum. The classes instructed for three 45- minutes' sessions in a week.

Traditionally designed biology instruction was that the teacher was the instructor or the source, and conveys the information directly to the students. The instructor directly explained the steps of the cell division. During this part the instructor used the white board in order to draw the movements of the chromosomes and wrote down the important terms with their meanings, and some transparencies, and expected students to draw the picture of the stages in the appropriate place of their worksheets (See Appendix E). During this process the instructor used questioning

technique in addition to the explanation. At the end of the first 45- minutes lesson the instructor finished explanation of first meiotic division and closed the lesson with questioning for making revision. At the end of the second 45- minutes lesson the instructor covered the rest of the phases and made revision with questioning by using the same methods as in the first lesson. Later on questions on the worksheet was answered. Teacher gave the answers by reading the questions. Questioning was used as well to get the answers from the students. Still since the main source of knowledge was the instructor, approval of the any answer was done by him/ her. Students were expected to write the answers on the appropriate places.

In the third 45- minute lesson instructor explained the oogenesis by lecturing. Again as in the case of the meiosis main usage of the white board was to draw the figure and write down the important points. In order to represent the division transparencies were used. Moreover at the end of the lesson teacher constructed a chart on the board that represents comparison of the meiotic cell division and oogenesis by comparing the number of daughter cells that are produced, movement of the chromosomes, reduction of the chromosome number, number of cell that is produced at the end of the first meiotic cell division. While constructing the chart questioning technique applied. At the end worksheets (See Appendix F) were delivered by the teacher as homework and expected to be done for the beginning of the next 45- minute lesson.

Other 45- minute lesson was about the spermatogenesis. Before explaining spermatogenesis, homework related with the oogenesis was checked. Later on teacher gave the answer of the worksheet by explaining the reasons of the answers. Questioning was used as well to get the answers from the students. Students were expected to check their answers. Once the answers were given, teacher used the same techniques as in the previous lesson while explaining the spermatogenesis. Again white board used for drawing figure and writing down the important points. Then by the help of the transparencies division explained once more by the teacher. At the end of the lesson teacher constructed a chart on the board that represents comparison

of the meiotic cell division and spermatogenesis by comparing the number of daughter cells that are produced, movement of the chromosomes, reduction of the chromosome number, number of cell that is produced at the end of the first meiotic cell division.

The fifth 45 minute lesson was about the comparison of the spermatogenesis and oogenesis in addition to the explanation of the sperm and egg cell. At the beginning of the lesson teacher delivered a worksheet (See Appendix G) about the spermatogenesis and by reading one by one gave the answers as a revision of previous lesson. While answering the worksheet revision was made by lecturing. Than a comparison table was constructed by the teacher that compares spermatogenesis and oogenesis. Questioning technique was applied. In order to show the comparison with a figure of oogenesis and spermatogenesis transparencies has been used. Number of daughter cells that are produced, movement of the chromosomes, reduction of the chromosome number, and number of cell that is produced at the end of the first meiotic cell division were the main aspects of the comparison. At the end of the lesson anatomy of the sperm and egg cell discussed by the teacher, again figures were drawn on the board in addition to writing the important points.

Next 45- minute lesson was about the comparison of the sperm and egg cell. At the beginning of the lesson teacher showed figure of the sperm and egg by the help of the transparencies. While showing their figure, their structure also explained by lecturing method. Also questioning has been applied. Then a table was constructed by the teacher that compares sperm and egg cell. Presence of the nutrient and specialized membrane, size, and ability for movement were the main aspects of the comparison. At the end of the lesson teacher delivered a worksheet related with the comparison of the egg and sperm cell. Again by reading the worksheet, teacher gave the answers of the worksheet. Questioning was used as well to get the answers from

the students. Students were expected to write the answers on the appropriate places. During giving the answers revision of the lesson was made.

Seventh 45- minute lesson was about the male reproductive system. Teacher used lecturing and questioning as a main technique of the lesson. At the beginning of the lesson figure of the male reproductive system was shown by the transparencies. By the help of the lecturing method anatomy, functions of the parts of the male reproductive system explained one by one. Later on by simplifying the figure, system was drawn on the board. Parts that were discussed are shown on the figure by the usage of the questioning. At the end of the lesson students asked their questions about the system one by one and the teacher answered them.

Next 45- minute lesson was about the revision of the male reproductive system. At first teacher revised system by using the figure on the transparencies. Lecturing method has been used. In the second part of the lesson worksheet (See Appendix H) was delivered by the teacher to the students. As in the previous lessons, teacher gave the answers by reading the questions. Questioning was used as well to get the answers from the students. Students were expected to write the answers on the appropriate places. While giving the answers, revision was made again by lecturing. At the end of the lesson hormones that control the system explained as a brief summary.

Female reproductive system was the topic of the ninth lesson. As in the case of the male reproductive system teacher used lecturing and questioning as a main technique of the lesson. At the beginning of the lesson figure of the female reproductive system was shown by the transparencies. By the help of the lecturing method anatomy, functions of the parts of the female reproductive system explained one by one. Later on by simplifying the figure, system was drawn on the board. Parts that were discussed are shown on the figure by the usage of the questioning. At the end of the

lesson students asked their questions about the system one by one and the teacher answered them.

Tenth lesson was again about the female reproductive system. At the beginning of the lesson teacher made revision by using the figure on the transparencies. Lecturing was the main method in addition to questioning. After the revision worksheet (See Appendix I) about the female reproductive system was delivered. As in the previous lessons, teacher gave the answers by reading the questions. Questioning was used as well to get the answers from the students. Students were expected to write the answers on the appropriate places. While giving the answers, revision was made again by lecturing. At the end hormones that regulate the system explained as a brief summary.

Next lesson was about the fertilization and hormonal control of the male reproductive system. At first figure in the transparency was used while explaining the changes. Later on steps were written on the board by the teacher one by one. Then teacher delivered the worksheet (See Appendix J) about fertilization. As in the previous lessons, teacher gave the answers by reading the questions. Questioning was used as well to get the answers from the students. Students were expected to write the answers on the appropriate places. While giving the answers, revision was made again by lecturing. Then a diagram that demonstrates hormonal control of the male reproductive system was constructed on the board by the teacher, while explaining the interaction. Name of the hormones, their influence are all represented. Negative and positive feedback and their importance in regulating the amount of the hormones are emphasized during lecturing.

Twelfth lesson was about the hormonal control of the female reproductive system. Diagram was constructed on the board by the teacher. Diagram demonstrates relation between the hormones and their influence on the system. Negative and positive

feedback and their importance in regulating the amount of the hormones were emphasized during lecturing. Later on teacher explains hormonal and structural changes in the menstrual cycle by lecturing. Figure on the transparency was shown to the students. Each step was explained on the figure, and then hormones and their effect on each stage was written on the blackboard by the teacher.

Last 45- minute lesson was again about the menstrual cycle. Teacher shows a graph of the hormonal changes, thickness of the uterine wall, and structures in the ovary through the monthly menstrual cycle by a figure on transparency. Changes in each phase were emphasized. Later on worksheets about female hormonal control system of reproduction and male hormonal control system of reproduction (See Appendix K) was delivered to the students. Answers were given by the teacher while reading the questions and constructing the related table. Questioning was used as well to get the answers from the students. Students were expected to write the answers on the appropriate places. While giving the answers, revision was made again by lecturing.

In the experimental group social constructivist approach integrated with physical modeling and computer animations was applied. Main aim was to have variety of tasks for the students. Those tasks were completed by group work to create an increase in peer- peer interaction. In all of the activities that were done with a group work of the students groups were predetermined by the researcher. Groups were figured out by considering the heterogenity in terms of age, previous years' biology grade that was out of five, gender and type of achievement goal orientations they have. By this way peer- peer assistance were encouraged. In the beginning of each section class was organized as predetermined groups sit as a group in the beginning of the lesson. During activities that were done as a group, instructor leaded all the participants work collaboratively and prompted division of labor throughout the activity. Therefore active participation of the students was established. Main function of the instructor was to support students and create an environment that ensured zone of proximal development level of the students. Teachers were assumed as a model

for enthusiasm, thinking, dealing with errors and challenge. At the end of each activity, teacher was expected to prompt students mainly by questioning if there were still misunderstandings related with the concepts. Teacher gave feedbacks continuously during the activities in addition to avoiding competition. If needed students had a chance to replay the computer animations throughout the model construction or completing the given tasks.

In the first 45 minutes lesson meiosis was taught. At first teacher delivered the worksheets (See Appendix L) to the students while giving instructions about the lesson. Students were expected to demonstrate movement of chromosomes and draw the stage on the appropriate place in their worksheet. Before beginning the activity full animation was presented about the meiosis. Later on instructor showed animation of each stage one by one. While walking around the class student demonstrations were checked by the instructor. If there was any mistake in demonstration, students were expected to find the mistake by themselves. They could get help from their books and figure in their worksheet as well. Lesson ended at the end of the meiosis.

In the second lesson instructor brought magnets and dish clothes that represents chromosomes. Each group presented movement of the chromosomes in one stage on the board according to the activity they had done in the previous lesson. If any mistake in the movement detected, instructor made other groups to solve by manipulating with questioning. Then students worked on the questions in their worksheet as a group. At the end of the lesson instructor gave correct answers of the questions by getting the answers from each group. Each group told their answer to each of the questions. If answers vary between groups class would discussed the answers. If the discussion ended with the wrong answer teacher showed the animation once more and made them give the correct answer by manipulating with her questions. Before finishing the lesson students were asked to have play dough's with three different colors for the next lesson.

In the third 45 minute lesson oogenesis was explained. At first instructor delivered the worksheets (See appendix F) by giving instructions about the activity. Students were expected to construct a model of the division with their play dough as a group work after watching the animation of the oogenesis for two times. Reduction of the number of chromosomes, name and number of the cells were expected to be labeled. Labels that can be used were written on the board. During these processes teacher walked around and if detects any mistakes manipulate group of the students by questioning. Once the modeling part completed, each group changed their place and checked the model of each other. After model checking was completed, students filled in their worksheets as a group. At the end instructor reminded students to bring their play dough for the next lesson as well.

In the next 45 minutes lesson, at first worksheet check was done. Again each group told their answer to each of the questions. If answers vary between groups class would discussed the answers. If the discussion ended with the wrong answer teacher showed the animation one more time and made them give the correct answer by manipulating with her questions. Later on animation about spermatogenesis was shown, while students were making the model of it with their play dough. Again reduction of the chromosomes, name and number of chromosome of the cells were expected to be shown and labels that were expected were written on the board. During these processes teacher walked around and if any mistakes detected, group of the student manipulated by questioning. Once the modeling part completed, each group changed their place and checked the model of each other.

Students filled in their worksheet (See Appendix G) about spermatogenesis in the beginning of the fifth lesson as a group. Again each group told their answer to each of the questions. If answers vary between groups class would discussed the answers. If the discussion ended with the wrong answer teacher showed the animation one more time and made them give the correct answer by manipulating with her questions. After these a table that compares spermatogenesis, oogenesis and meiosis

was constructed by the students as a group work. Number of chromosomes, number of daughter cells, timing of the reduction of the chromosomes, usage of mitosis in the beginning and its' timing was the headings given by the instructor. Each table was constructed on the transparencies and presented by the group to the whole class. If there was any mistake on the table, instructor manipulated the class by questioning. At the end of the class students were informed about bringing different colored play dough for the next lesson as well.

In the sixth lesson anatomy of the sperm and egg cell in addition to their comparison was the main topic. In the beginning of the lesson worksheet was delivered to the students. They were expected to analyze the instruction given in the worksheet and underline the sentences related with the structure of the sperm and egg cell as a group work. Once analysis finished models for egg and sperm cell was done by labeling the mitochondria, flagellum, cell body and acrosome of the sperm in addition to showing yolk, cortical granules and zonappelucida of the egg cell. Later on each group constructed a table that compares the structure of the egg and sperm cell. During these processes teacher walked around and if any mistakes detected, group of the student manipulated by questioning. Once models and the table accomplished each group changed their place and checked the model and table of each other. Students reminded to gather different colored play dough for the next lesson.

Seventh lesson was about male reproductive system. At the beginning of the lesson instructor showed animation about the anatomy and the function of the structures of the system. After watching the animation for two times, name of the structures were written on the board by the instructor. Students were expected to construct a model of the male reproductive system that represents the label of the parts. The role of instructor was to walk around manipulate the mistakes that has been done by the help of questioning. Once models were constructed each group changed their place and checked the model and table of each other. At the end of the lesson empty papers were delivered, and students were expected to write their questions about the male

reproductive system that they were curious about. Each paper was collected by the instructor. After the lesson instructor eliminate unrelated questions.

In the eight 45 minutes lesson instructor delivered worksheets (See Appendix H) about the system. At first students filled the worksheet by group work. Then answers of the questions were given by the students. Again each group told their answer to each of the questions. If answers vary between groups, class would discuss the answers. If the discussion ended with the wrong answer teacher showed the animation one more time and made them give the correct answer by manipulating with her questions. After these teacher gave at most two questions that were written by the students in the previous class to each group. If necessary additional knowledge were expected to answer, instructor gave handout that had the information. Students were expected to give answers. At first questions were discussed within the group. Later on each group told their questions, and gave the answer they could figure out. Instructor manipulated the students to find the correct answers by the help of the questioning.

Other 45 minutes lesson was about the female reproductive system. Again same procedure was applied during the lesson as in the male reproductive system. At the beginning of the lesson instructor showed animation about the anatomy and the function of the structures of the system. After watching the animation for two times, name of the structures were written on the board by the instructor. Students were expected to construct a model of the female reproductive system that represents the label of the parts. The role of instructor was to walk around manipulate the mistakes that has been done by the help of questioning. Once models were constructed each group changed their place and checked the model and table of each other. At the end of the lesson empty papers were delivered, and students were expected to write their questions about the female reproductive system that they were curious about. Each paper was collected by the instructor. After the lesson instructor eliminate unrelated questions.

In the tenth 45 minutes lesson instructor delivered worksheets about the system. At first students filled the worksheet (See Appendix I) by group work. Then answers of the questions were given by the students. Again each group told their answer to each of the questions. If answers vary between groups, class would discuss the answers. If the discussion ended with the wrong answer teacher showed the animation one more time and made them give the correct answer by manipulating with her questions. After these teacher gave at most two questions that were written by the students in the previous class to each group. If necessary additional knowledge were expected to answer, instructor gave handout that had the information. Students were expected to give answers. At first questions were discussed within the group. Later on each group told their questions, and gave the answer they could figure out. Instructor manipulated the students to find the correct answers by the help of the questioning.

Implantation and fertilization in addition to the male hormones were the topic of the next 45 minutes lesson. At first instructor showed the animation about the implantation and fertilization, later on worksheet (See Appendix J) was delivered to the students. While students were filling their worksheets' as a group work, instructor showed the animation one more time. Then answers of the questions were given by the students. Again each group told their answer to each of the questions. If answers vary between groups, class would discuss the answers. If the discussion ended with the wrong answer teacher showed the animation one more time and made them give the correct answer by manipulating with her questions. Once the worksheet part completed, instructor showed animation about the male hormones. The animation represented GnRH, LH, FSH, testosterone in addition to the glands that they were secreted. Two papers one of which was labeled with one of the glands and the other with one of the hormones was given to each group. Also handout (See Appendix K) about the hormones of the male reproductive system was given. At first groups were expected to figure out the role of the gland and the hormone that were written on the paper as a group. Than instructor showed the paper with the pituitary gland and asked for the hormone that it secretes. One of the students from the group that had the hormones came up and asked for the gland that they effect. Activity

ended till all of the labels were asked. Instructor manipulated the correct sequence of the link by questioning. Students that came up with the asked label, explained the hormone or the gland that they represent. At the end of the lesson students were reminded to bring play dough for the next lesson.

Twelfth lesson was about the female hormones. Again animation was shown by the instructor. Once it was shown handout was given to the groups. Each group was expected to make a model about the hormonal relation between the hypothalamus, pituitary gland and ovaries. Also they need to represent changes in the ovary, in addition to the wall of uterus as well. Instructors' role was to detect any mistakes in the model while walking around the class. If any mistake was detected, students were manipulated by the help of the questioning. Once models were constructed each group changed their place and checked the model of each other. After completing the activity worksheet was delivered and was expected to fill in by group work. At the end of the lesson instructor delivered a handout that has information from a magazine (See Appendix M). Handout was about loss of fat and its relation with infertility. Students were expected to figure out whether the information given was scientific or not for the next lesson.

In the thirteenth lesson at first the parts in the worksheet that were not filled in due to lack of time was completed again by the group work. Later on answers of the questions were given by the students. Again each group told their answer to each of the questions. If answers vary between groups, class would discuss the answers. If the discussion ended with the wrong answer teacher showed the animation one more time and made them give the correct answer by manipulating with her questions. Once the activity completed, handout that was delivered in the previous lesson was asked from the students. At first students asked to discuss whether the situation was realistic or not within their groups. Once they figured out the result with reasoning, they told their decision at first to the instructor. Instructor split up the class as "it is scientific" group and "it is not scientific group". Debate was manipulated between

the two groups by the instructor. At last teacher manipulate the answer by questioning.

Therefore it could be concluded that students in the experimental group exposed to different aspects of social constructivist approach as well as physical modeling and computer animation. Table 4.7 represents a checklist for the treatment of the experimental group related with the dimensions of social constructivism and physical modeling in each of the 45 minutes lessons.

Table 4.7 Dimensions in the physical modeling and computer animation integrated with social constructivist learning environment per lesson

Dimensions	Lessons												
Social constructivism	1	2	3	4	5	6	7	8	9	10	11	12	13
Conceptual conflicts	X		X	X	X	X	X	X	X	X	X	X	X
Problem solving	X		X	X	X	X	X	X	X	X	X	X	X
Reflection		X	X	X	X	X	X	X	X	X	X	X	X
Authenticity								X		X			X
Group work	X	X	X	X	X	X	X	X	X	X	X	X	X
Instructor as a scaffolder	X	X	X	X	X	X	X	X	X	X	X	X	X
Emphasis on meaning	X	X	X	X	X	X	X	X	X	X	X	X	X
Learners responsible for their own learning	X	X	X	X	X	X	X	X	X	X	X	X	X
Social labour activities	X	X	X	X	X	X	X	X	X	X	X	X	X
Questioning	X	X	X	X	X	X	X	X	X	X	X	X	X
Signs	X	X	X	X		X	X	X	X	X	X	X	
Play tool	X	X	X	X		X	X		X			X	
Verbal thinking	X	X	X	X	X	X	X	X	X	X	X	X	X
Sharing of ideas	X	X	X	X	X	X	X	X	X	X	X	X	X
Dialogue:discussions, debates	X	X	X	X	X	X	X	X	X	X	X	X	X
Peer- peer interaction	X	X	X	X	X	X	X	X	X	X	X	X	X
Peer- teacher interaction	X	X	X	X	X	X	X	X	X	X	X	X	X
Feedback	X	X	X	X	X	X	X	X	X	X	X	X	X
Physical Modeling													
Tool and sign	X	X	X	X		X	X		X			X	
Visualization	X	X	X	X		X	X		X			X	
Divide concepts or subjects	X	X	X	X		X	X		X			X	
Observation and manipulation of objects, systems and processes	X	X	X	X		X	X		X			X	
Concrete representatives of abstract and microlevel concepts	X	X	X	X		X	X		X			X	
Active engagement or hands on activities	X	X	X	X		X	X		X			X	
Decontextualization		X	X	X		X	X		X			X	

CHAPTER 5

RESULTS

The results were divided into four sections. At first pretest results of the Science Process Skills Test (SPST), Pre- Human Reproductive System Conceptual Test (Pre-HRSCT) and Pre- Students' Motivation toward Biology Learning Questionnaire (Pre- SMTBL) later on in the second section post test results for post-HRSCT and post- SMTBL presented. In the other section pretest result of the Pre- Achievement Goal Questionnaire (Pre- AGQ) results demonstrated. Lastly in the fourth section post test results for Post- Achievement Goal Questionnaire (Post- AGQ) represented.

5.1 Statistical Analysis of Pre- test Scores

Before applying treatment independent sample t- test analysis conducted to figure out whether there were any statistically mean differences between control groups and experimental groups in terms of SPST, pre- SMTBL and pre- HRSCT. Statistical analyses were performed at .05 significance level using SPSS 11.

Descriptive statistics for the SPST, pre- SMTBL and pre- HRSCT scores of overall sample, experimental group and control group has been presented in Table 5.1. For gathering overall students' motivation towards biology learning scores, results of the items that were related with the performance goals subscale were reversed as in the case of the study Tuan, et al., (2005) to measure intrinsic motivation level of the

students. In the table OV, EG and CG referred to the overall sample, experimental group and control group with respectively. As seen from this table all of the descriptive were appropriate to conclude that pre- test scores can be assumed as normal. Kurtosis and Skewness values were in between -2 and +2.

Table 5.1 Descriptive statistics with respect to SPST, pre- SMTBL, pre- HRSCT and ASTB scores across overall sample (N=125), experimental (N= 52) and control groups (N=73)

		Mean	SD	Skewness	Kurtosis
SPST Scores	OV	21.41	6.47	-.477	-.423
	EG	20.21	6.10	-.508	-.256
	CG	22.26	6.63	-.557	-.675
Pre- SMTBL Scores	OV	95.51	13.87	-.101	.210
	EG	96.89	14.04	-.387	.413
	CG	94.53	13.75	.100	.318
Pre- HRSCT Scores	OV	7.49	3.14	.213	-.200
	EG	7.29	2.31	.019	-.504
	CG	7.63	3.62	.165	-.589

Once normality assumption established, independent sample t- test analysis was conducted. As it can be seen from the table 5.2, in all tests there were no significant difference between experimental and control group. For the tests pre-SMTBL and SPST *p* value for the Levene's test of variances were greater than 0.05. Therefore equal variances can be assumed.

For the comparison of the mean values in between control and experimental group, again for both of the tests *p* values are greater than the alpha level. *p* values for pre – STMBL and SPST were 0.907 and 0.81 with respectively. When results for the pre- HRSCT considered equal variances cannot be assumed since *p* value for the Levene's test was lower than the alpha level. When the appropriate *p* value chosen for the t- test (0.521), it was figured out that, *p* value was greater than the alpha level. Therefor again for the pre- HRSCT it could be concluded that there were no significant mean difference between the control and the experimental group. In conclusion it was assumed as there was no significant mean difference between EG and CG for these test and questionnaire scores. From table 5.1 similarities of the means can be observed as well.

Table 5.2 Independent sample t- test for SPST, pre- SMTBL and pre- HRSCT scores

		Levene's Test for Equality of Variances		t- test for Equality of Means	
		F	*p*	df	*p*
SPST	Equal variances assumed	1.564	.213	123	.081
	Equal variances not assumed			115.214	.077
Pre- SMTBL	Equal variances assumed	1.286	.259	123	.907
	Equal variances not assumed			119.855	.904
Pre- HRSCT	Equal variances assumed	10.381	.002	123	.550
	Equal variances not assumed			121.729	.521

5.2 Statistical Analysis of Post- HRSCT and Post- SMTBL

The hypotheses 1.1 and 1.2 stated in Chapter 3 were tested by using MANOVA since there weren't any significance differences between the experimental groups and controlled groups with respect to SPST, pre- HRSCT and pre- SMTBL scores. In this statistical analysis post test results for post- SMTBL and post-HRSCT were dependent variables and type of treatment is the independent variable. Statistical analyses were performed at .05 significance level using SPSS 11. In addition to measure total intrinsic motivation towards biology learning as in the study of Tuan, et al., (2005) results for the subscale "performance goals" of the post- SMTBL again were reversed.

Descriptive statistics for the dependent variables were represented in the Table 5.3. As it can be seen from the table students in the experimental group had higher mean in both post- HRSCT and post- SMTBL scores, when it was compared with the control group.

Table 5.3 Descriptive statistics with respect to post- HRSCT and post- SMTBL scores across overall sample (N=125), experimental (N= 52) and control groups (N=73)

		Mean	SD	Skewness	Kurtosis
Post-HRSCT	OV	16.78	4.78	-.251	-.634
	EG	20.52	2.81	-.690	.462
	CG	14.11	4.06	.219	.450
Post-SMTBL	OV	109.02	19.11	.255	-.993
	EG	127.42	11.44	-.089	-.517
	CG	95.92	10.86	.336	-.524

In order to understand whether these mean differences were significant or not MANOVA was decided to be applied. Before conducting MANOVA assumptions of independence of observation, level of measurement, random sampling and normal distribution controlled. It was assumed that students took the tests independent from each other in addition to preventing any interaction during the administration of the tests. Moreover teachers were warned about controlling independence of the students during taking the tests. Later on assumptions like linearity, homogeneity of regression, multicollinearity and singularity and homogeneity of variance-covariances matrices were checked by SPSS 11. For multivariate normality assumption skewness and kurtosis values for the dependent variables were checked. From table 5.3 it can be seen that skewness and kurtosis values were in between +2 and -2, therefore accurate with univariate normality in addition to being a sign for multivariate normality. For Multivariate Normality Mahalanobis distances were figured out. Maximum value for this distance was 8.32 which were under the critical value (13.82) for two dependent variables with alpha level .0001. Since the value

was below the critical level it was concluded that there were no multivariate outliers in the data. Homogeneity of variance- covariance matrices was checked through Box's test and Levene's test. Box's Test result showed that the covariance matrices of the dependent variables were equal across groups sine *p* (.047) value was above .001. Results of Levene's test are shown in Table 5.4 demonstrated that each dependent variable has the same variance across groups since *p* values were larger than 0.05.

Table 5.4 Levene's test of equality of error variances

	F	df1	df2	*p*
Post- HRSCT	3.781	1	123	.054
Post- SMTBL	.057	1	123	.812

Since assumptions of the MANOVA were accomplished, results of the tests were interpreted. Results were demonstrated in the table 5.5.

Table 5.5 MANOVA results with respect to the collective dependent variables

Source	Wilks' Lambda	Multivariate *F*	Hypothesis df	Error df	Sig. (*p)*
Type of Treatment	.206	235.759	2	122	.000

The findings indicated that there was a significant mean difference between experimental group and control group with respective to the colligative of dependent variables. In order to find out whether the difference were due to the one of the stated dependent variables or not, according to Pallant (2007) Tests of Between- Subjects Effects can be applied. He suggested to apply higher alpha level since number of separate analysis were conducted in order to reduce Type 1 error. For doing this he prefers Bonferroni adjustment. In that respect since there were two analyses original alpha level of .05 divided by 2 giving new alpha level .025.

Table 5.6 Test of Between- Subject Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	*F*	*p*
Type of Treatment	Post- HRSCT	1247.624	1	1247.624	96.508	.000
	Post- SMTBL	30142.729	1	30142.729	244.623	.000

The findings indicated that there was a significant mean difference between experimental group and controlled group on understanding of human reproductive system conceptions in both of the dependent variables in the favor of the experimental group. As it can be seen from the Table 5.6 for the Post- HRSCT p=.000 which is below the .025, therefore can be concluded as there was a significant mean difference in the favor of experimental group. For Post- SMTBL p value was again the same, which is .025, so it can be concluded as there was a significant mean difference between control and experimental group in the favor of the experimental group.

Figure 5.1 and 5.2 represents comparison between pre- HRSCT and post- HRSCT mean scores across experimental group and controlled group respectively. According to the figure 5.1 and 5.2 there were differences in the mean scores of pre- HRSCT and post- HRSCT in both experimental and controlled groups. Also significant mean differences at the end of the treatments can be observed from these two figures. On the other hand as it can be seen from the figure difference was more in the experimental group.

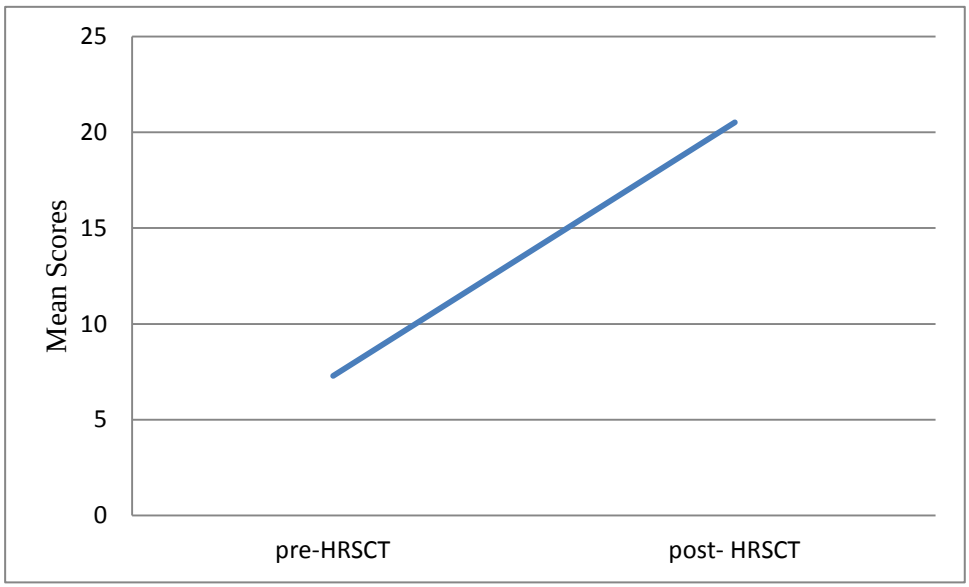


Figure 5.1 Comparison of pre- HRSCT and post- HRSCT means scores of experimental group

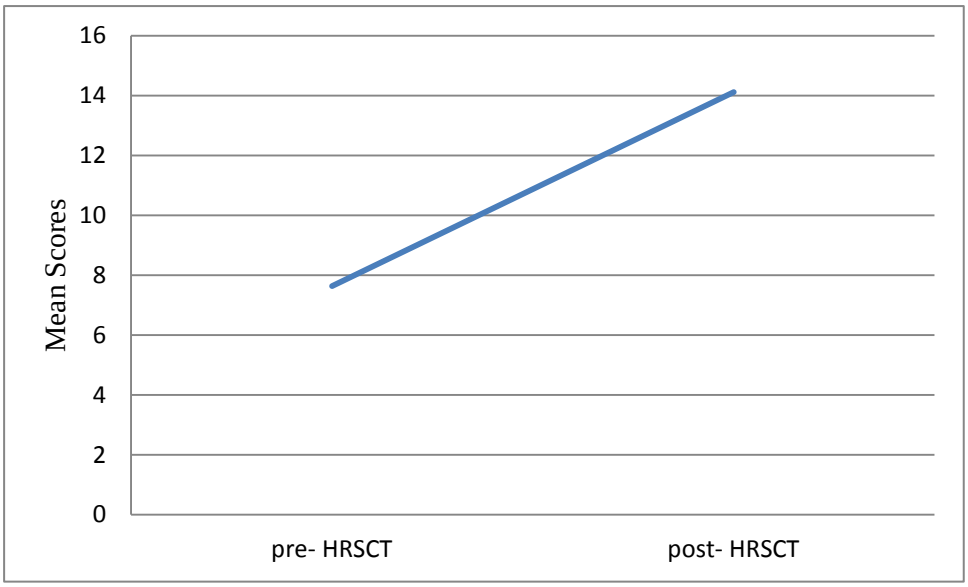


Figure 5.2 Comparison of pre- HRSCT and post- HRSCT means scores of controlled group

Figure 5.3 and 5.4 represents comparison between pre- SMTBL and post- SMTBL mean scores across experimental group and controlled group respectively. According to the figure 5.3 and 5.4 there were differences in the mean scores of pre- SMTBL and post- SMTBL in both experimental and controlled groups. Also significant mean differences at the end of the treatments can be observed from these two figures. On the other hand as it can be seen from the figure difference was more in the experimental group.

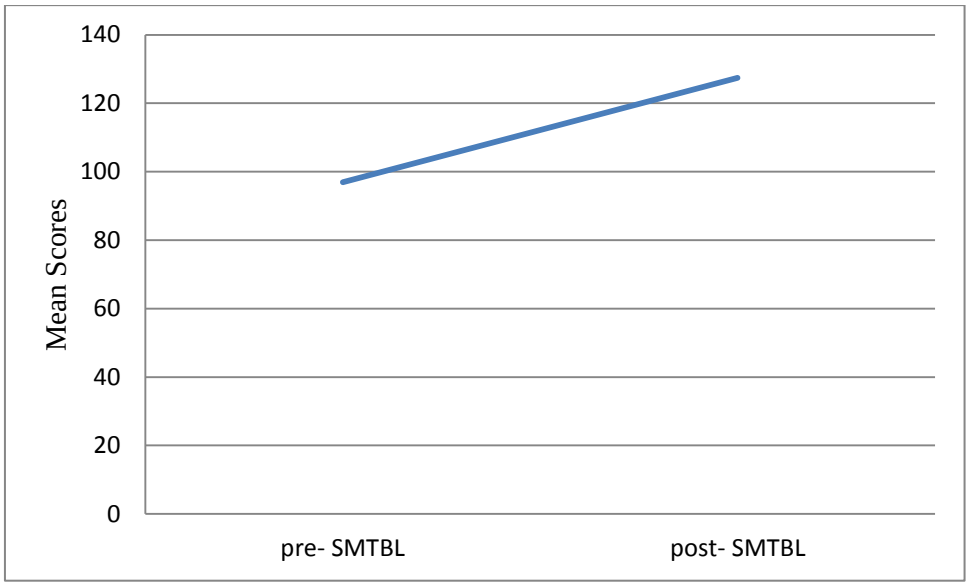


Figure 5.3 Comparison of pre- SMTBL and post- SMTBL means scores of experimental group

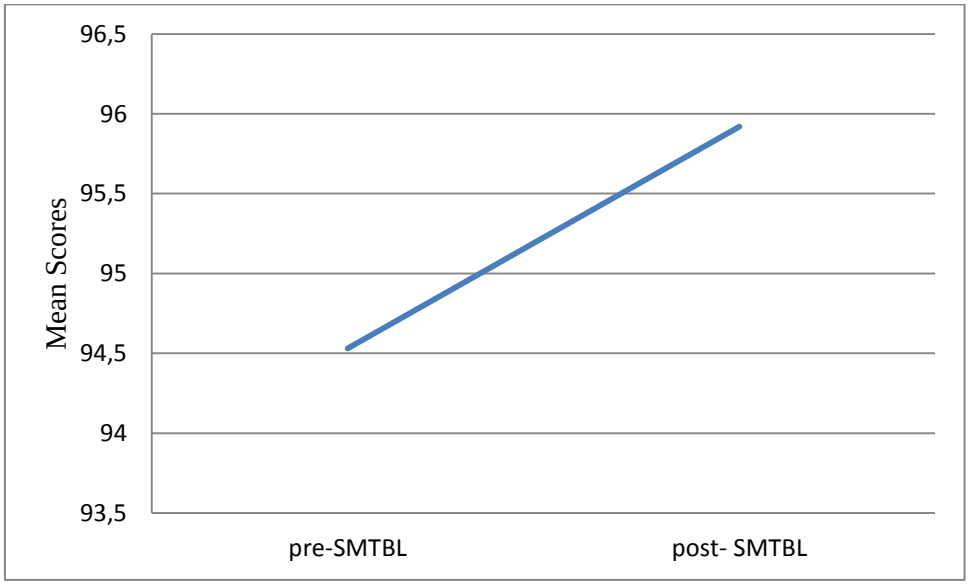


Figure 5.4 Comparison of pre- SMTBL and post- SMTBL means scores of control group

Students' responses on post HRSCT and SMTBL were examined. The percentages of students' responses on the post-HRSCT were shown in figure 5.5. As it can be seen from the figure students correct responses in the experimental group on post-HRSCT were greater than the control group. Therefore it could be told as treatment had an effect on elimination of students' misconceptions in meiosis and human reproductive system unit. For each item students correct responses and misconceptions were examined. Proportion of misconceptions held by the students' in control groups was higher than that of in the experimental groups in most items. Highest amount of difference between experimental group and control group can be observed in items 1, 2, 9, 10, 11, 12, 13, 14, 17, 18, 19, 21, 22, 23, 25 and 26 in the favor of experimental group.

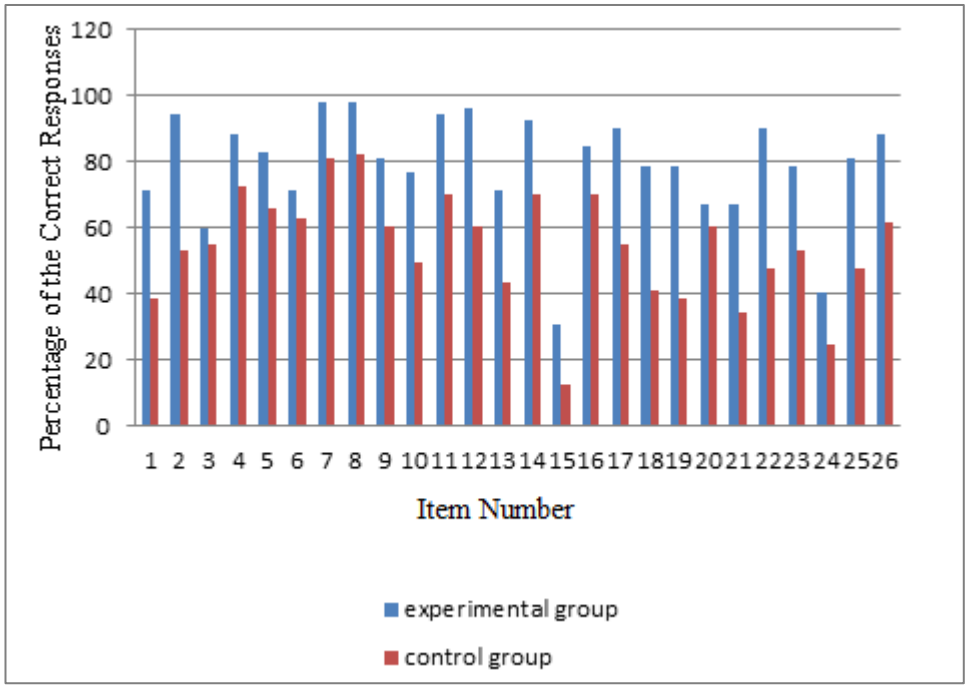


Figure 5.5 Comparison of the percentages of the students' correct responses on pre-HRSCT and post- HRSCT across experimental and control groups

In item 1 students were asked to identify structures of the chromosome during meiosis from the diagram. Common misconception about the structure of the chromosome is related with its conversions between chromatids, chromatin and the chromosome that is duplicated. After applying the treatment, the proportion of students who answered this item correctly was 71.2% in the experimental group whereas 38.4% in the control group. Since both of the groups' scores were below 75% on this item, unsatisfactory understanding of the concept can be suggested. Response that represents misconception to this question was "A chromosome has always two chromatids during cell division". 39.7 % of the students in the control group chose this response, whereas it was only 11.5% within the experimental group. Students may have difficulties in differentiating chromosomes and chromatids. Item 2 is the other item that created large difference between two groups. Within the item identification and labeling of the formation of the spindle fiber was asked. 94.2 % in experimental group and 53.4% in control group answered the item correctly. The common misconception is that students may assume centrioles located in nucleus and thought that spindle fibers are made by nucleus. Other misconception related with the concept is that "spindle fibers are formed from centromeres". Since the correct responses were above 75% in experimental group, satisfactory understanding of the concept can be suggested. As a response that represents misconception, "Spindle fibers are formed from centromere" were chosen by 15.1% within the control group whereas it was 1.9% within the experimental group. Moreover 9.6% of the students in the control group have chosen "Spindles are formed within the nucleus" as a misconception. It was chosen by only 1.9% of the students in the experimental group.

For item 9, two diagrams are given and students were asked to compare and contrast oogenesis which is a specialized type of meiosis and meiosis. The common misconception is that since there was a difference in cytoplasmic cell division in oogenesis, there must be a difference in terms of chromosomal composition as well. 60.3% of the students in control group gave correct response to this item.

However the percentage of the students in the experimental group answering the item correctly was 80.8%. One of the alternative as a misconception "Number chromosome of the cells that are produced at the end" was preferred by 13.7% of the students in the control group. Whereas it was only 3.8% in the experimental group. Other alternative as a misconception was "Number of the homologous chromosomes that are present during cell division" and preferred by 9.6% percent of the students in the experimental group on the other hand it was 13.7 % in the control group. In the 10^{th} item students were expected to identify and compare daughter cells with body cells from the same diagrams. Students may think genetic information of the cell remains constant at the end of meiosis as a misconception. In addition as a misconception they may assume as after crossing over, cells that are produced may differ from the parent cells but identical within the daughter cells. 76.9% of the students in experimental group responded the question correctly in contrast only 49.3% of the students in control group gave correct answer. One of the alternative response as a misconception was "Genetically different cells with same amount of genetic information as a body cell" was preferred by 15.1% of the students in the control group, whereas it was 5.8% in the experimental group. "Genetically identical cells with the same amount of genetic information as body cell" was the other alternative as a misconception and was preferred by the 9.6% of the students in the control group, whereas it was 1.9% in the experimental group. As discussed before, in experimental group both for item 9 and 10 correct responses were above 75% which showed that satisfactory understanding of the concept can be suggested.

Item 11 was related with identifying the part that produces sperm cells. Most of the students thought scrotal unit produces sperm rather than the testis as a misconception. Within the experimental group 94.2 % of the students gave the correct answer whereas it was 69.9% of the students in the control group. Alternative as a misconception for the item was the label of the scrotum. 1.9% in the experimental group and 1.4% of the students in the control group have chosen the alternative. Item 12 was also related with the male reproductive system. Students are expected to differentiate reproductive system from excretory system. Most of the

time those two systems were given together in the books as a diagram while explaining reproductive system since some parts of excretory system were used in reproduction as well. Common misconception originated from usage of same parts within those two systems. Students assume urinary bladder as an accessory gland or bulbourethral gland, which is the gland that connects to vasdeference at the point where it is attached to urethra, as a part of excretory system. 96.2 % of the students in the experimental group gave correct responses to this item. However the percentage of students in control group answering the item correctly was 60.3 %. Alternative as a misconception to the item was the label of the urinary bladder. 15.1% of the students in the control group, 1.9% of them in the experimental group have chosen the alternative. Moreover, label of bulbourethral gland is also given as an alternative that represents the misconception. 11.1% in the control group have chosen the alternative in the control group. Whereas none of the students chosen the alternative in the experimental group. Function and identification of the testis was questioned in item 13. Students assume that since reproductive and excretory systems are connected in a way, removal of testis may result with preventing proper functioning of urination. 43.8% of the students in the control group gave the correct response to the item. On the other hand amount of correct responses was 71,2% within the experimental group. Alternative as a misconception for the item was "prevent proper urinary function". 1.9% of the students in the experimental group and 5.5% of the students in the control group have chosen the alternative. For items 11 and 12 it could be told as satisfactory results are gathered on the other hand unsatisfactory result can be seen in item 13 since correct responses were below 75%.

Item 14 was related with the identification and function of the fallopian tube. Misconception related with the item was that students assume any manipulation in female reproductive system may cause disturbance in pregnancy. Again the amount of correct responses was higher in the experimental group when it was compared with the control group. Within the experimental group 92.3% of the students gave the correct responses whereas it was 69.9% in control group. The alternative as a misconception was "A pregnancy in progress would be disturbed". 17.8 % of the

students in the control group and 5.8% of them in the experimental group have chosen the alternative. Experimental groups' percentages were in concordance with the satisfactory level.

Item 17 was related with the hormonal control of the female reproductive system. Identification of the hormonal relationship has been questioned. The objective of the question was to state the hormonal control centers of the female reproductive system. Common misconception of neglecting role of brain within the sexual hormone production was questioned. Within the experimental group 90.4 % of the students answered the question correctly. In contradiction with this in the control group only 54.8% of the students gave the correct response. Alternative as a misconception to the question was "ovaries only". It was preferred by 4.1% of the students in the control group. On the other hand it was higher in the experimental group with 9.6 %. Item 18 was also related with the female hormones. Students were expected to create a relationship between the LH and release of the egg while evaluating the graph. Related with the graph students have many misconceptions in addition from the popular literature students were more informed about menstruation than the cycle and ovulation. Since releasing the egg initiates menstruation, they thought it as directly related with the menstruation phase which is the last days of the cycle. In addition other misconception due to the related item is that, ovulation happens at the very beginning of the cycle. Only 41.1 % of the students answered the question correctly in control group. 78.8% of the students in the experimental group gave correct answer. One of the alternatives for the items as a misconception was "between 5^{th} and 10^{th} days" which is the very beginning of the cycle and chosen by the 15.1 % of the students in the control group, whereas it was only chosen by the 3.8% of the students in the experimental group. Moreover "between 16^{th} and 26^{th} day" was the other alternative as a misconception. 16.4% and 7.7% of the students have chosen the alternative from control and experimental group with respectively. "On the 28^{th} day" was the last alternative as a misconception. In control group it was preferred by 13.7% of the students. Whereas 3.8% of the students have chosen the alternative in the experimental group. Item 19 was related with the same topic as

well. Judging the role of the pituitary gland was asked according to the given information. Common misconception about the item is that parts of brain do not have any effect on the reproductive system. 78.8 % of the students in the experimental group gave correct answer, whereas only 38.4% of the students in the control group answered the question correctly. “Ovaries influence uterus” was the alternative as a misconception. According to the given information the influence is in terms of development of the uterus. 6.8 and 3.8% of the students have chosen the alternative in the control and experimental group with respectively. For these three items satisfactory level for correct responses were reached in experimental group percentages, since they were all above 75% level.

Item 21 was related with fertilization. Identification of the place of fertilization from the given diagram was expected. Students have misconceptions related with the location of fertilization. Some assume it within ovaries since egg is produced in there. Moreover some of them suggest cervix and uterus as other possible fertilization places. Within the experimental group 67.3 %, in control group 34.2% of the students gave correct answer, which was below satisfactory level. Students have difficulties in differentiating the location which is also indicated by the percentages which are below satisfactory level 75%. Alternative as a misconception for the item was “ovary”. It was chosen by 15.1% of the students in the control group, whereas it was 11.5% in the experimental group. Item 22 was again related with the same topic. Timing of the fertilization was questioned. Students had lots of misconceptions about the topic due to the popular literature. For increasing the possibility of getting pregnant females have hormonal injections. Students assume increase in hormone levels have greater impact than the location of the egg as a misconception. In addition students have a tendency to think “fertility would increase either in the very beginning or at the end of the menstrual cycle” as a misconception. 90.4% of the students in the experimental group, 47.9% of the students in the control group answered the question properly. The item answered in experimental group in satisfactory level since the percentage of correct answers were above 75%. The alternative as a misconception was “when progesterone level is increasing”. It was

preferred by 19.2% of the students in the control group, whereas 5.8 % of them preferred it in the experimental group.

Item 23 was related with the menstrual cycle. Effect of the estrogen and progesterone was asked. Students may also evaluate the question by the diagram. Misconception related with the item was to think estrogen and progesterone indirectly proportional with each other, since they are controlled with negative feedback mechanism. 53.4% of the students in control group, 78.8% of the students in the experimental group gave the correct response. Correct response for the item was above 75% satisfactory level for the experimental group. Alternative as a misconception was "uterus lining thickens" and "estrogen level falls". 20.5% of the students in the control group and 11.5% of them in the experimental group have chosen the alternative as a response.

Item 25 was related with the hormonal control of the male reproductive system. Identification of the hormonal relationship has been questioned. The objective of the question was to state origin of the testosterone which is the main sex hormone of the males. Main misconception about the item is again to neglect cooperation between the brain and testes in the sexual hormone production. 80.8% of the students in the experimental group and 47.9% of the students in the control group gave the correct answer to the question. Again within the experimental group correct responses were above satisfactory level. One of the alternative as a misconception was "testes only" and preferred by 19.2% of the students in the control group, whereas it was 3.8 % in the experimental group. Other alternative as a misconception was "scrotum only" and preferred by 8.2% of the students in control group. 1.9 % of the students in the experimental group have chosen the same alternative. Last alternative as a misconception was "epididymis and testes" and was preferred by 1.9% and 13.7 % of the students in experimental and control groups with respectively. Lastly in the item 26, fertilization was questioned. Identification of the factors needed to present in order to make fertilization happen was the objective of the question. Students

thought that it is enough to have egg and sperm together to make fertilization happen as a misconception. They neglect the cellular level which is the fusion of two different cells within the egg. 61.6% of the students in the control group and 88.5% of the students in the experimental group gave the correct response to the question. Experimental group had higher correct response proportion when it was compared with the control group and the correct responses were above 75% satisfactory level. Alternative as a misconception was "an egg must be present in the fallopian tube" and "sperm must swim into one of the fallopian tube (oviduct)". It was preferred by 4.1% and 1.9% of the students in control and experimental groups with respectively.

Other items were also having higher correct response levels in the experimental group but not as high as the items that are listed above. But still they have differences in the percentage of choosing the alternative that is determined as misconception. One of the items that clearly show the difference is the item 3. Aim of the item was to question the period where chromosome number reduced during meiosis. As a misconception students have a tendency to think that it is reduced at the end of division since it is the aim of the division. Alternative as a misconception was "Anaphase2- Telophase2" and chosen by 23.3% of the students in control group, whereas only 9.6% of them have chosen it in the experimental group.

Item 24, showed the difference clearlyas well. Hormone that is responsible for producing testosterone was questioned. As a misconception students neglect role of brain, so the hormones that are synthesized from them during the male sexual hormone production was neglected. In addition popular literature makes them aware of androgen earlier than the LH. 47.9 % of the students chose the alternative "Androgen" that is placed as misconception in the control group. On the other hand only 13.5% of the students have chosen it in the experimental group.

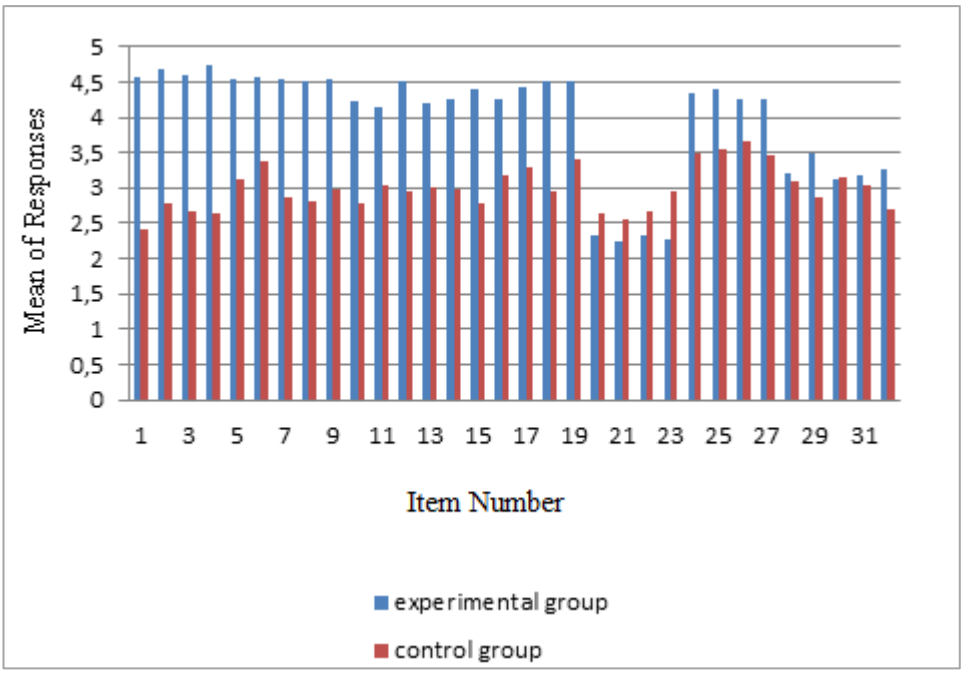


Figure 5.6 Comparison of the mean values of students' correct responses on post-SMTBL across experimental and control groups

The mean of students' responses on the post- SMTBL were shown in figure 5.6. As it can be seen from the figure students mean responses in the experimental group on post- SMTBL were greater than the control group most of the items except for the items 20, 21, 22 and 23. Those four items were related with the "performance goal" subscale of SMTBL and were not reversed while analyzing subscales one by one.

By considering the factor analysis results subscales of the SMTBL can be considered as six subscales. Data related to each of these subscales were analyzed separately. Descriptives of the students in these subscales are presented in the table 5.7.

Table 5.7 Descriptive statistics with respect to SE, ALS, BLV, PG, AG and LES scores across overall sample (N=125), experimental group (N= 52) and control group (N=73)

		Mean	SD	Skewness	Kurtosis
SE	OV	25.00	8.24	-.429	-1.239
	EG	32.23	2.49	-.723	-.082
	CG	19.85	6.92	.344	-.938
ALS	OV	24.65	6.94	-.273	-.844
	EG	30.40	3.63	-.371	.982
	CG	20.55	5.72	.173	-.264
BLV	OV	18.33	4.84	-.321	-.917
	EG	22.08	2.97	-.933	.287
	CG	15.66	4.10	.003	-.847
PG	OV	13.14	4.62	-.233	-.882
	EG	9.17	3.12	.386	-.117
	CG	10.84	4.07	.190	-.437
AG	OV	10.14	3.78	.375	-.232
	EG	20.48	2.74	-.606	-.090
	CG	17.26	3.82	-.857	1.068
LES	OV	12.30	3.55	-.016	-.505
	EG	13.06	2.45	-.393	-1.024
	CG	11.77	4.09	.299	-.680

As it can be seen from the table 5.7 and 5.8 students in the experimental group had higher mean scores in most of the subscales, when it is compared with the control group.

Self efficacy (SE) subscale of the questionnaire considered seven items. Mean scores of the experimental group was *M*= 32.23, which was higher than the control group (*M*= 19.85). In addition mean score of the experimental group was higher than the midpoint of the subscale scores. High score in this subscale means that while learning biology the student has a strong belief in him/ her ability regardless of the difficulty of the topic. Therefore experimental group believe in their ability more than the control group while they were accomplishing biology task. They have higher tendencies in terms of believing in their ability of understanding material presented in biology lessons. Moreover they trust themselves in a better way to perform well in the tests regardless to its difficulty. Experimental group showed negative skewness, which shows loading in the higher scores when it was compared with the positively skewed scores of the control group.

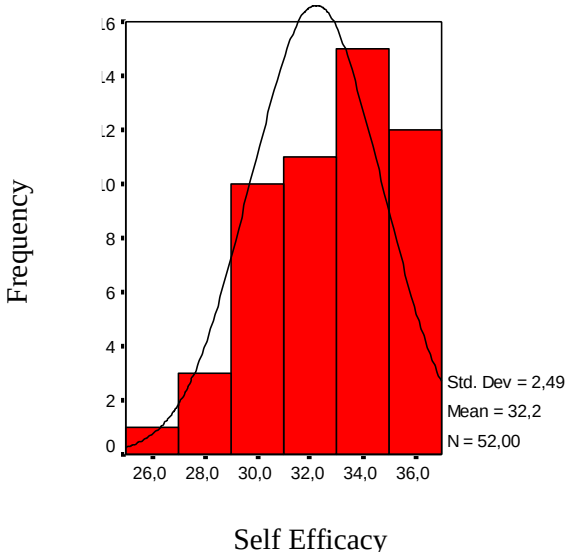


Figure 5.7 Range of Self Efficacy scores for EG students

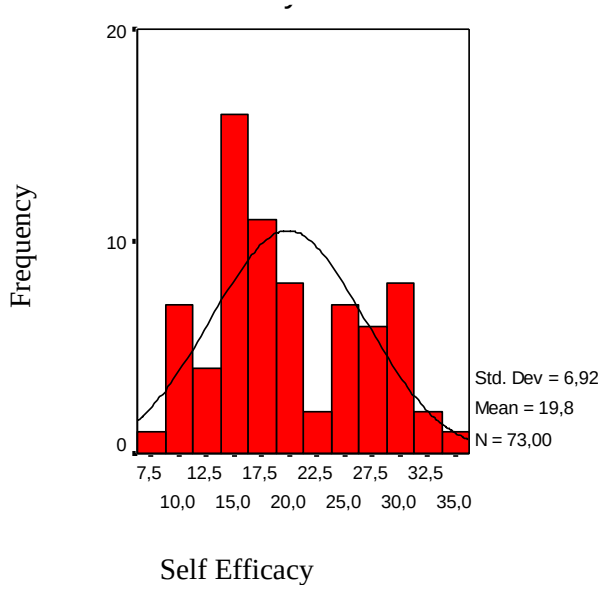


Figure 5.8 Range of Self Efficacy scores for CG students

Other subscale for the questionnaire was ALS, which has seven items needed to be considered. Mean score for the experimental group was *M*= 30.40, again was higher from the mean of the control group (*M*= 20.55) and also mid point of the subscale. Therefore it can be concluded as students in the EG were more motivated in terms of taking active role in biology learning. Moreover results show that they had higher tendencies in terms of constructing new knowledge. Motivation in terms of finding new resources that will help him/ her was again higher in the experimental group. When it comes to find reasons for their mistakes, students in the EG group were better in addition to be better participants in the discussions between their peers and teachers. They were keen on relating newly presented material with previous experiences. Moreover experimental groups' skewness was negative which supports higher yield of students in the higher scores.

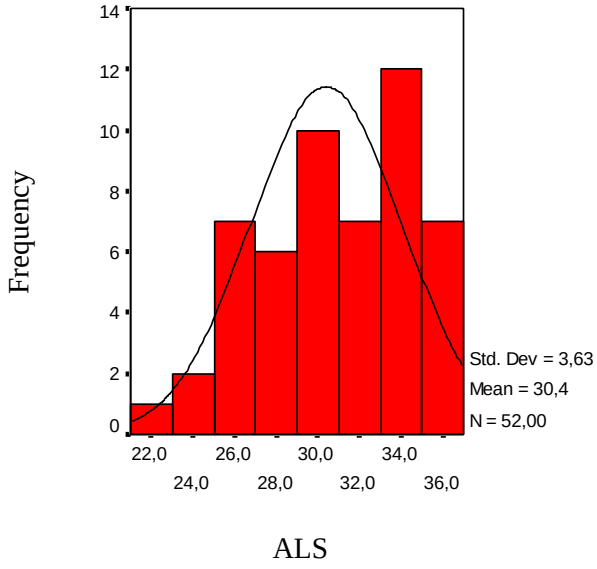


Figure 5.9 Range of ALS scores for EG students

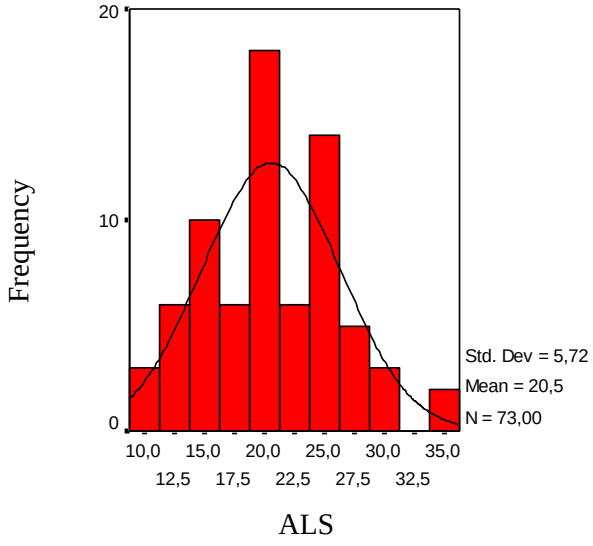


Figure 5.10 Range of ALS scores for CG students

Another subscale was biology learning value (BLV), which has considered 5 items. Value of biology learning according to the students was measured. Mean value for the experimental group (22.08) was again higher than the control group (15.66) and also from the midpoint of the subscale scores. This indicates that students in the experimental group had a higher tendency in terms of considering the material they learned in the class related with the daily life. Moreover in order to satisfy their curiosity they allowed use of inquiry activities and development of scientific skills. In addition experimental groups' skewness was negative which supports yield of students in the higher scores within the subscale of the experimental group.

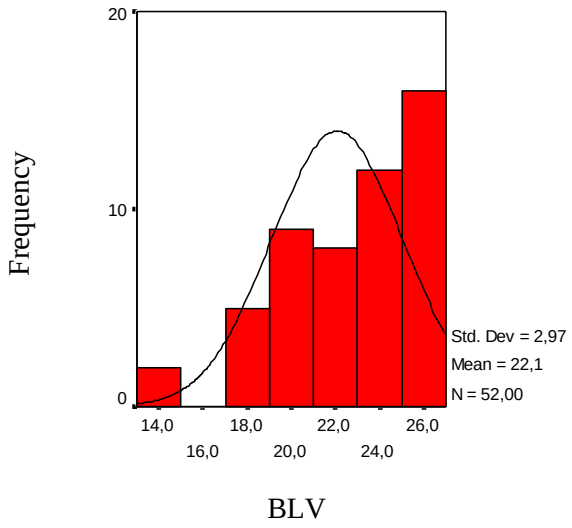


Figure 5.11 Range of BLV scores for EG students

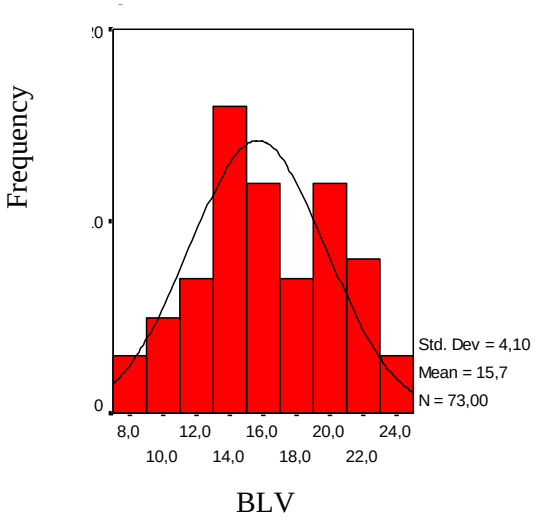


Figure 5.12 Range of BLV scores for CG students

Other subscale was the performance goal (PG) that was measured by the 4 items. Control group had slightly higher mean score (10.8) from the experimental group (9.2). Moreover both of the groups' mean scores were below the midpoint of the subscale. The results indicate that students in the control group had slightly higher tendencies to engage in an activity that is recognized by the others. Moreover they have higher tendencies to perform better than the other students in addition to getting good grades. Therefore students in the control group have slightly more tendency to demonstrate competence. Figure 5.10 represents range of the score for the PG.

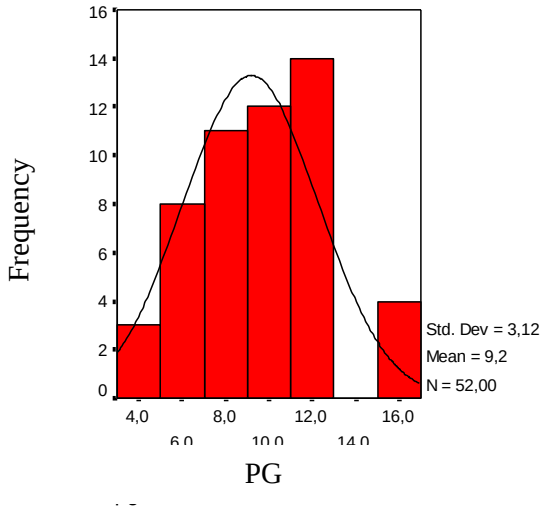


Figure 5.13 Range of PG scores for EG students

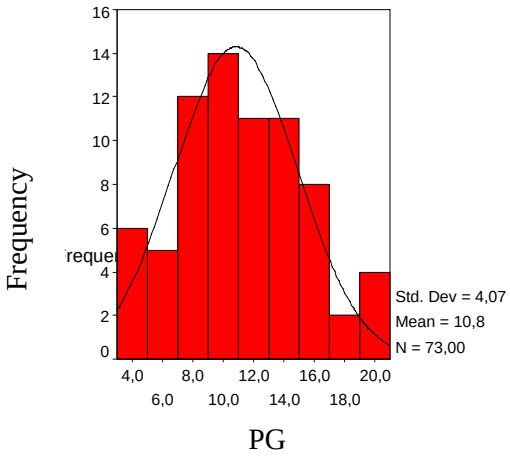


Figure 5.14 Range of PG scores for CG students

Achievement goal (AG) subscale has 5 items and analyzed as a subscale of the questionnaire as well. Experimental group had mean *M*= 20.48, which is slightly higher than the control group (17.26). Moreover mean score of the experimental group was higher than the midpoint of the subscale. Since mean value of the EG students was higher than the CG, it could be conclude as, students in the EG engages academic tasks in the purpose of increasing their ability in biology. Intrinsic motivation of the experimental group was slightly higher than the students in the CG.

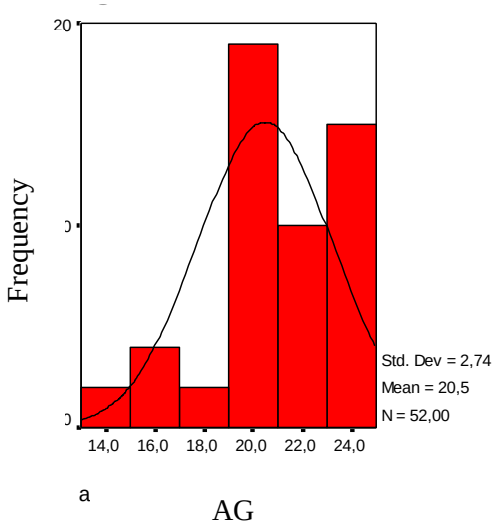


Figure 5.15 Range of AG scores for EG students

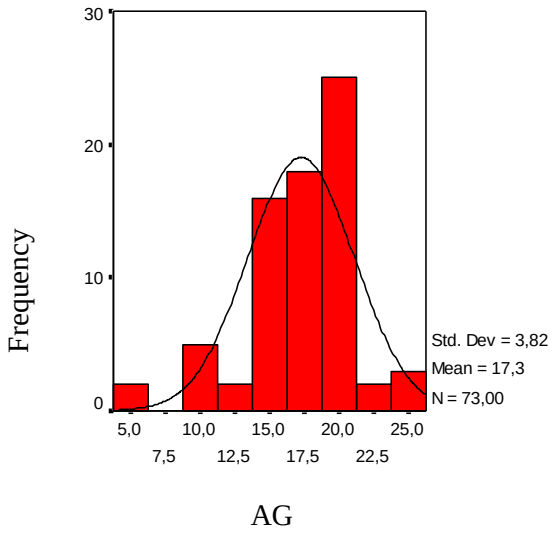


Figure 5.16 Range of AG scores for CG students

Last subscale of the questionnaire was learning environment stimulation (LES) with four items. Mean score of the experimental group student was *M*= 13.01, whereas it was 11.8 for the CG. Therefore mean score of experimental group was slightly higher than the control group and the midpoint of the subscale. Results show that there is a difference in terms of student motivation towards learning biology resulting from the classroom environment, teacher- student and student- student interactions in the favor of the experimental group. Since experimental group was negatively skewed it can be concluded as number of the student who yields on the higher scores for the subscale was more than the experimental group.

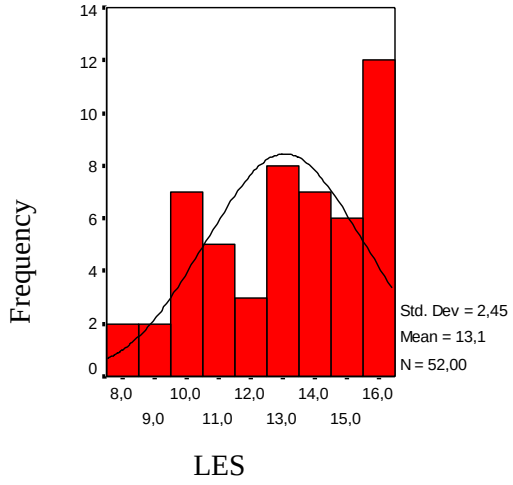


Figure 5.17 Range of LES scores for the EG students

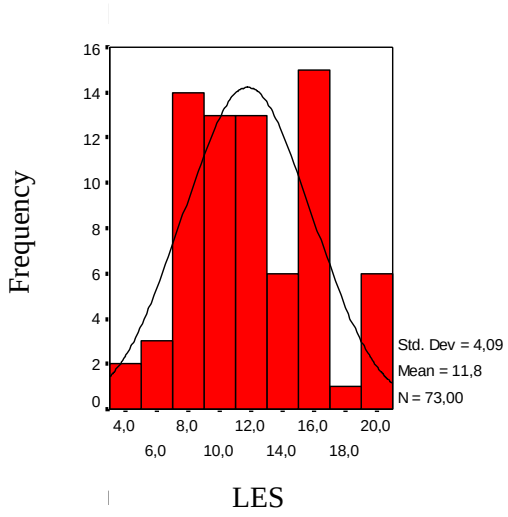


Figure 5.18 Range of LES scores for the EG students

5.3 Statistical Analysis of Pre- Achievement Goal Questionnaire Scores across Experimental and Control Group

Prior treatment whether sample is normal or not was checked. Statistical analyses were performed at .05 significance level using SPSS 11. Descriptive for the different types of achievement goals in the pre- Achievement Goal Questionnaire scores such as pre- mastery approach orientation(PMA), pre- mastery avoidance orientation(PMAV), pre- performance approach orientation(PPA) and pre- performance avoidance orientation(PPAV) across overall sample (OV), experimental group (EP) and control group (CG) have been presented in Table 5.8. As seen from this table all of the descriptive were appropriate to conclude that pre- test scores can be assumed as normal. Kurtosis and Skewness values were in between -2 and +2.

Table 5.8 Descriptive statistics of pre- Achievement Goal Questionnaire scores across overall sample (N=125), EG(N= 52), CG(N= 73), females (N= 65) and males (N=60)

		Mean	SD	Skewness	Kurtosis
Pre- Mastery Approach	OV	13.08	3.41	-.819	.119
	EG	14.10	2.63	-1.125	1.269
	CG	12.37	3.74	-.523	-.719
Pre- Mastery Avoidance	OV	12.74	2.53	-.545	.170
	EG	13.40	1.99	-.726	.305
	CG	12.27	2.77	-.285	-.082
Pre- Performance Approach	OV	12.82	2.97	-.016	-.321
	EG	11.83	2.24	.269	-.525
	CG	13.54	3.22	-.428	-.083
Pre- Performance Avoidance	OV	11.50	2.67	.027	-.307
	EG	10.40	2.60	.128	-.787
	CG	12.27	2.46	.106	.064

From Table 5.9 it can be clearly seen that there was a significant mean differences between control and experimental group for PMA, PMAV and PPA, PPAV with *p* values 0.003; 0.009; 0.001 and 0.000 with respectively. This significant mean differences were seen in the favor of EG for PMA and PMAV; CG for PPA and PPAV according to the Table 5.8. Moreover according to the results of the pre-achievement goal questionnaire, subscales PMA, PMAV, PPA and PPAV were decided to be used as covariate during the analysis of the post- Achievement Goal Questionnaire.

Table 5.9 Independent sample f- test results for PMA, PMAV, PPA and PPAV

		F	*p*	df	*p (2 tailed)*
PMA	Equal variances assumed	12.595	0.001	123	0.005
	Equal variances not assumed			122.987	0.003
PMAV	Equal variances assumed	4.999	0.027	123	0.013
	Equal variances not assumed			122.981	0.009
PPA	Equal variances assumed	4.820	0.030	123	0.001
	Equal variances not assumed			122.938	0.001
PPAV	Equal variances assumed	1.107	0.295	123	0.000
	Equal variances not assumed			105.796	0.000

5.4 Statistical Analysis of Post-Achievement Goal Questionnaire Scores across Type of Treatment

Descriptive for the types of achievement goals in the post- Achievement Goal Questionnaire scores for post- mastery approach orientation(MA), post- mastery avoidance orientation (MAV), post- performance approach orientation (PA) and post- performance avoidance orientation(PAV) across overall sample, experimental group and control group have been presented in Table 5.10.

In the table OV refers to the overall sample moreover EG and CG refers to experimental group and control group with respectively. As seen from this table all of the descriptive were appropriate to conclude that pre- test scores can be assumed as normal. Kurtosis and Skewness values were in between -2 and +2.

Table 5.10 Descriptive statistics of MA, MAV, PA and PAV scores across OV (N=125), EG(N= 52), CG(N= 73), females (N= 65) and males (N=60)

		Mean	SD	Skewness	Kurtosis
Post-Mastery Approach	OV	13.89	2.60	-.452	-.028
	EG	14.40	2.25	-.732	.474
	CG	13.52	2.78	-.233	-.184
Post-Mastery Avoidance	OV	12.34	2.32	.195	-.091
	EG	12.29	1.86	.072	.135
	CG	12.37	2.61	.201	-.406
Post-Performance Approach	OV	13.81	2.74	-.282	-.278
	EG	12.65	2.64	.657	.020
	CG	14.63	2.51	-1.034	1.859
Post-Performance Avoidance	OV	12.07	2.53	.348	.062
	EG	10.81	2.11	.605	1.321
	CG	12.97	2.42	.178	.123

For figuring out whether there is a significant mean difference between post-Achievement Goal Questionnaire scores ANCOVA was applied, where pre-test results for each type of goal were used as covariate.

Before applying ANCOVA for the comparison in between different types of goals, related assumptions like influence of treatment on covariate measurement, reliability of covariate, linear relationship between dependent variable and covariate, homogeneity of regression slope, level of measurement, random sampling, independence of observations and normal distribution were established. It was assumed that students took the tests independent from each other in addition to preventing any interaction during the administration of the tests.

According to table 5.11 we have enough evidence to conclude that there was a significant relationship between the pretest scores of each type of goal orientation scores and post- test scores. As it can be seen for each case moderate correlation was observed. Moreover each of these correlations can be assumed as significant since *p* value was smaller than alpha level.

Table 5.11 Pearson Correlation Coefficient for each of the pre and post test scores of MA, MAV, PA and PAV scores

Pre- Goal Orientation	Post- Goal Orientation	
Mastery Approach	Pearson Correlation	.297
	Significance	.001
Mastery Avoidance	Pearson Correlation	.348
	Significance	.000
Performance Approach	Pearson Correlation	.384
	Significance	.000
Performance Avoidance	Pearson Correlation	.384
	Significance	.000

When the value for the difference of the type of achievement goal questionnaire scores across type of treatment was checked, as it can be seen from table 5.12 for PA (.002) and PAV (.000) *p* value is lower than α- level. This indicates that there was a significant mean difference. This significant mean difference was in the favor of the control group for performance approach goal orientation. Situation can be supported by the table 5.10 since mean values for EG and CG were 12.65 and 14.63 with respectively. Moreover same case was observed for the performance avoidance goal orientation as well. Significant difference between the mean values of EG (10.81) and CG (12.97) was in the favor of the control group.

For the mastery approach (.263) and mastery avoidance goal orientation (.255) *p* value was greater than the α- level, therefore there was no significant difference between the scores of the two groups in between type of treatments.

Table 5.12 ANCOVA Results

	Type III Sum of Squares	df	Mean Square	F	Sig
MA	7.857	1	7.857	1.264	.263
MAV	6.214	1	6.214	1.309	.255
PA	62.174	1	62.174	10.387	.002
PAV	76.114	1	76.114	15.537	.000

CHAPTER 6

DISCUSSION, IMPLICATION AND RECOMMENDATIONS

The main goal of this study was to evaluate the effect of computer animation and physical modeling integrated social constructivist approach on the students understanding of human reproductive system and motivation towards biology learning in addition to their tendency towards different types of achievement goal orientation. To accomplish this goal, (i) a human reproductive system conceptual test was developed and validated, (ii) achievement goal orientation questionnaire was adapted in order to measure type of achievement goal orientation, (iii) physical modeling and computer animation integrated social constructivist instructional method developed, (iv) SPST, AGQ, HRSCT, SMTB were administered before the implementation of the instructional method to collect data as pre- test, (v) the instructional method implemented to experimental group whereas traditional techniques were used in the control group, (vi) HRSCT, SMTB and AGQ was administered again to collect data, (vii) data was evaluated by using MANOVA statistical analysis for understanding of human reproductive system and motivation towards biology learning, in addition to usage of ANCOVA statistical analysis for measuring the effects of social constructivist approach integrated with computer animation and physical modeling on preferring different types of achievement goal orientation.

6.1 Summary of the Experiment

At the beginning of this study related literature about students' misconceptions in human reproductive system in addition to meiosis concepts were reviewed. Later on those misconceptions were discussed with the biology teachers in order to figure out their validity in semi structured interviews. Two different instruction methods were designed for the study. An instruction based on the social constructivist approach also integrated with computer animation in addition to physical modeling was designed for the experimental group. On the other hand traditionally designed instructional method was applied to the control group of the study. The main purpose of the study were to investigate effectiveness of social constructivist approach that is integrated with computer animation and physical modeling on students understanding of human reproductive system in addition to motivation towards biology as a subject and types of achievement goal orientation they have. According to the findings in the literature related with the misconceptions of the students in the human reproductive system and discussions about those misconceptions with the biology teachers, in addition to suggestions related with how to increase student motivation towards a subject and changing the type of the type of achievement goal orientation was considered during planning the study. Plan covers the tests that were going to applied, activities that were going to be used; lesson plans of the instructions that were going to be implemented.

Six biology classes of grade ten biology courses consisted of 125 students (60 male and 65 female) participated this study. Three of those classes were assigned as experimental group and the other three were assigned as the control group randomly. In the experimental group there were 52 students whereas there were 73 students in the control group. The study was conducted for four weeks. There were three 45 minutes teaching sessions per week in each group.

At the beginning of the study SPST, SMTB, HRSCT and AGQ were administered to both groups as pre- tests. Independent sample t- test analysis was used to analyze the results of these tests in order to figure out the differences between experimental and control group. Moreover HRSCT, SMTB and AGQ were applied as post- tests as well in order to examine the effectiveness of the instructions with different aspects as stated in the main goal of the study. In order to analyze the test scores of the HRSCT and SMTB MANOVA was used, whereas to examine the results of the AGQ ANCOVA was conducted.

The results of the independent sample t- test revealed that there was no significant mean difference between control group and experimental group in terms of students' understanding of human reproductive system concepts, scientific processing skills, and motivation towards biology as a school subject before the treatment. In contradiction with these there were significant mean differences between the groups in terms of type of the achievement goals they had. Therefore AGQ scores were used as covariate during analysis of the post AGQ scores.

There were three biology teachers both of which had two classes one from experimental and one from control group throughout the investigation. Teachers had already information about social constructivism and conceptual change. Also before implementation phase, teachers were trained about the details of the implementation of both computer animation and physical modeling integrated social constructivist approach and traditional approach.

6.2 Discussion of the Results

One of the findings of the study revealed that physical modeling and computer animation implemented social constructivist instruction causes significantly better acquisition of scientific conceptions than the traditional instruction. This finding is also accurate with the literature (Brown, 1990; Clark & Mathis, 2000; Daşdemir, Doymuş, Şimşek & Karaçöp, 2008; Gardner & Belland, 2012; Lin, 2011; Ilyas, Rawat, Bhatti & Malik, 2013; Rotbain, Marbach- Ad & Stavy, 2007; Sarıkaya, Selvi & Bora, 2004; Stravroulakis, A. M., 2005; Wu & Tsai, 2005). The presence of the misconceptions in the conceptual framework of the students in the control group after the treatment would be the main reason for their poor progress. Also focus on students' misconceptions during the treatments could be clearly figured out by the difference between the control and the experimental group. Acquisition of new conceptions as consequences of the exchange and differentiation of the existing concepts, and integration of new concepts with the existing ones are strategies of conceptual change that was used within the method prompted the change in misconceptions (Çakir, Geban & Yürük, 2002).

In order to create such a difference in terms of understanding, different aspects of social constructivism had important roles. One of the important features of social constructivism that creates the difference was peer and social interaction. It is known that increase in the peer/ social interaction has an impact on creating conceptual change (Uzuntiryaki, 2003). Since students were working collaboratively in computer animation and physical modeling integrated social constructivist approach and teacher served as a facilitator and scaffold students, peer- student interaction in addition to peer- teacher interaction was higher in experimental group. As stated in the study of Palmer (2005) learning increases once the interaction of the students with teacher and peers increases. That kind of an interaction helps individuals to interpret physical and social world around them. By language students share ideas and search for clarification until they feel like they understand.

So communication rich environment created opportunities to negotiate meaning. In addition in the study of Başer (2006) it was revealed that social interaction serves an important role in terms of creating conceptual change. Within the study effectiveness of cognitive conflict based physics instruction were investigated over traditional instruction in terms of creating conceptual change. Experimental group treated with constructivist approach that emphasizes active engagement, demonstrations, discussion between peers, use of analogies if possible and experiments. In the end experimental group showed significantly higher level of conceptual change. One of the factors that were suggested as an explanation for this result was students' interaction with each other to share ideas about the situation. This was also the main intention of the physical modeling and computer animation integrated social constructivist approach. During completing the given tasks, which were mostly constructing physical models, students were prompted in a way to activate their alternative conceptions, be in an environment that present a situation that could not explain existing concepts, create cognitive conflict about the situation, search for other conceptions to explain situation, actively construct their own knowledge and have new conceptions that was helpful to solve similar problems in future (Başer, 2006). As stated in the study of Başer (2006) these factors are parallel with both constructivism and conceptual change theory of Posner, et al., (1982).

In addition to the effect of the peer and teacher interaction, scaffolding also had an important effect for creating better understanding. Palmer (2005) stated that scaffolding of the teacher help students to develop knowledge and skills while making connections with pre- existing knowledge. Therefore during the implementation of computer animation and physical modeling integrated social constructivist approach scaffolding was emphasized. Both instructors and computer animations served the role of guiders to provide scaffolding to the students who have difficulties. Computer animation also had a second role within the approach in terms of providing scaffolding. Besides being a representative with auditory and visual aspects (Lin, 2011), computer animations gave more time to the instructor to circulate around the group to scaffold the students as in the study of Rotabin,

Marbach- Ad & Stavy (2007). Moreover to make scaffolding more effective zone of proximal development of the students were considered as well while preparing and selecting the activities (Driscoll, 2005).

Another important aspect of social constructivism is collaborative learning and it is also important in creating meaningful learning as stated in the study of Bay, Bagceci &Cetin (2012). It also supports peer learning (Summers, 2006). In order to make collaborative learning effective for creating better understanding, partners must have shared understanding. To create that, discussions that were prompted with questioning were used to clarify and reduce differences in understanding of the students (Driscoll, 2005). They were expected to construct physical models or complete a given task as a group. In order to accomplish these, they needed to discuss the procedure or method they would apply to complete the given task as a whole. During those discussions they compared their prior knowledge, which was really high due to the media effect and being teenager since the topic was human reproductive system. Therefore a particular social and cultural context created which is an important aspect of social constructivism. In addition worksheets were completed as a group work, answers were given group by group, and if they were wrong, teacher prompted students to correct answers by questioning. If there were differences between the answers of the groups, teacher created a context which created an environment to made them discuss their different conceptions. The questions teacher were prompted was mostly related with the real life context. Therefore students created intelligible, plausible conceptions which were useful in a variety of new situations. Findings of the study Akar (2003) also revealed that discussions of the students with their classmates and instructors have an important role in retaining the knowledge.

Usage of tools and signs has an important role in the difference between experimental and control groups in terms of understanding as well. Tools were helpful for constructing an active learning environment since it is known that within

a constructivist class, students learned through engagement in active learning tasks (Akar, 2003). Also usage of tools and skills with students' social partners are necessary for social constructivism as Driscoll (2005) cited from Tudge & Rogoff (1989). In this study physical models were served as both tools and signs in addition to creating an active learning environment. While constructing the physical model students as a group leaded to discuss what they know about the concepts, in addition to how to use the tools that were given them. In such an environment language was also helping students to seek for clarification with their peers in addition to sharing ideas (Credler, 2005). They had a chance to be treated with play tools' beneficial impacts on proceeding conceptual abilities and developing capacities for abstract concepts (Driscoll, 2005). Moreover after constructing the model students were expected to present what they constructed as a group. By this way physical models served as decontextualizaiton tool by being signs (Driscoll, 2005). In such an environment students observed different schemes for same concepts which leaded to decontextualization (Driscoll, 2005). In addition to these when words and gestures are not enough static and dynamic representations serve as a language tool (Trindade, et al., 2002). Therefore computer animations were also integrated to social constructivist approach in addition to physical models to enhance usage of sign and tools besides their other benefits as being visuals. By being signs they were useful for communication, development of mental abilities, internal cues, monitoring of ones' remembering and thinking (Credler, 2005). Therefore by the help of the approach students used language and other signs to internalize the concepts which would lead to an extension in understanding (Driscoll, 2005).

Integration of modeling and visualization to enhance constructivist instruction was also advised by researchers who have implemented constructivist approach (Gilbert, Justi & Aksela, 2003). Moreover the idea of using physical modeling and computer animation in biology teaching is not new. It is an effective situation since students do not relate what they learn to understanding the anatomical and physiological implication just by working on diagrammatic drawings of the human reproductive system (Gott, et al., 1985). A number of studies carried out with both physical

modeling (Malacinski & Zell, 1996; Rotbain, Marbach- Ad & Stavy, 2006; Stravroulakis, 2005; Templin & Fetters, 2002) and computer animation (Demircioğlu & Geban, 1996; Sanger, Brecheisen & Hynek, 2001; Williamson & Abraham, 1995; Yakışan, Yel & Mutlu, 2009) to find out the effectiveness of teaching in terms of understanding the science concepts, which revealed improvement in the student understanding.

In order to create a better understanding constructing a physical model enhanced social constructivist approach by representing abstract and complex concepts of human reproductive system (Sarıkaya, Selvi & Bora, 2004).). In the case of models and modeling in science education, models are used as the source analog, which then act as an instructional tool in reasoning about the target analog and for understanding a new concept (Rotbain, Marbach-Ad & Stavy, 2006). This is such an important aspect mainly for the topic meiosis. It has abstract and cellular level concepts which are difficult to visualize (Öztap, Özay & Öztap, 2003). As stated in the study of Öztap, Özay & Öztap (2003) ultra-structure of cell is not well known by the students and makes it difficult to visualize the process of cell division. It is natural to have misconceptions for concepts that are abstract and difficult to directly observe (Başer, 2006). Moreover it is a known fact that as a whole human reproductive system is a difficult topic to learn as well (Saral, 2008). It has other abstract concepts rather than meiosis like gametogenesis which is based on meiosis. By considering those problematic areas, physical modeling help understanding not by just visualization but also by preventing memorization (Lock, 1997). In the study of Sarıkaya, Selvi & Doğan Bora (2004) it was stated that creation of active participation to hands on activities and visualization in addition to being able to divide concepts or subjects into sub pieces make the topic easy to learn and prevent memorization. Models create a context to observe and manipulate many real objects, systems, processes or mental phenomena that cannot be observed and manipulated directly under normal circumstances. Therefore students reach to abstract concepts in a way that is in concordance with their cognitive ability (Clark & Mathis, 2000).

In this study by making students construct a physical model, hands on active learning environment was created for increasing understanding (Küçükahmet, 2000). It is a known fact that active engagement into construction of a physical model increases achievement both in high and low cognitive questions as in the study of Lazarowitz & Naim(2013). During constructing the model students have a chance to figure out their misconceptions (Sarıkaya, Selvi & Doğan Bora, 2004).

Therefore constructing physical models collaboratively serve as a guide to create a dilemma which is an important aspect of conceptual change (Coştu, Ayas, Niaz, Ünal & Çatik, 2007) in addition to serving as a representative for micro level and abstract concepts. Students needed to solve the conflicts about the concepts as a group in order to figure out the conception they shared in common to construct the model. As well as creating a dilemma, a zone for proximal development was created as well.

Besides enhancing social constructivism by visualization in order to scaffold students while solving their conflicts through construction of physical models computer animations were used in addition to attempts of the instructor. Animations are pictures in motion and analogous to a subset of visual graphics (Weiss, Knowlton, & Morrison, 2002). They are helpful in terms of increasing students understanding of concepts in addition to enhancing accurate conceptions about scientific processes (Gardner & Belland, 2012). Concepts which are difficult to learn and teach in addition to being abstract and micro level, like cell division, protein synthesis and material transfer through cell membrane, can be perceived accurately by the help of the animations in addition to understanding of the concepts and changing misconceptions (Yakışan, Yel & Mutlu, 2009). It is a known fact that computer animations enhance development of visualization skills as well as ability to think in the process at micro level (Sanger, Brecheisen & Hynek, 2001). As being dynamic visuals, animation can represent more than one concept and their relations as an ongoing process (Yakışan, Yel & Mutlu, 2009). Therefore in addition to visualizing abstract concepts as in the case of physical modeling computer animations are more

useful for visualizing dynamic concepts and processes. Since human reproductive system composed of series of dynamic concepts and their relations as ongoing processes, like the link between hormones during menstrual cycle, gametogenesis, meiosis and release of the sperms through male reproductive system, usage of computer animations made it easier to understand those processes in addition to micro level concepts. These findings are also accurate with the literature. In the study of Yakışan, Yel & Mutlu (2009) it was stated that teaching dynamic and abstract concepts with static figures and pictures would create problems in visualization which will lead to construction of alternative concepts. Also Daşdemir, Doymuş, Şimşek & Karaçöp (2008) stated that change in figures or colors, emergence and extinction of some situations are useful in realization process of the events.

In our study computer animations were used in an active learning environment by the help of the worksheets and physical model construction to increase its benefits. In the study of Daşdemir, et al., (2008) it is advised to implement activities that enhance development of the skills to use animation techniques. This was also parallel with the study of Rotabin, Marbach- Ad & Stavy (2007). They also used activity booklet to create an interactive environment in their study. According to findings of the study it was suggested to use hands- on activities in addition to minds- on activities in addition to enhancing cooperative learning. Computer animations enabled students to figure out dynamics in the way they want. It can be watched as a whole or step by step. Another important finding of the study was that by the help of the computer animations students had a chance to separate different levels of structures. So in a way they can sub divide the concepts. Also computer animations made it easier to visualize the process and remember it. One of the important benefits of the computer animations that was revealed in the study was that teacher had a chance to move around the class. By that way direct feedback was given to the students and instructor examined their progress as well as paying attention to individual students. This was the main case within our study as well. It is important to enhance instructors' role as a facilitator within a social constructivist classroom. So usage of computer animations within an active learning environment not just helped by visualizing

dynamic and abstract processes or micro- level structures for the students but also helped the instructor by giving space. It gives more time for instructor to circulate around the groups. Therefore instructor had a chance to scaffold students more while they were constructing their physical models or completing the given tasks.

In addition to creating an active learning environment mainly by the help of the physical modeling, questioning was the main aspect of the computer animation and physical modeling integrated social constructivist approach. By the help of the questioning students were prompted to achieve specialized abilities, which is in concordance with the social constructivism (Driscoll, 2005). Lin (2011) conducted a similar study that compares effect of different instructional techniques integrated with computer animations. He compared the effect of giving feedback and questioning besides usage of computer animations with questioning besides usage of computer animations and just the use of computer animations within the instruction. All those feedbacks and questions were established by the computational module. Additionally he made further comparison with those techniques combined with static visuals rather than computer animations as well. Students received techniques with computer animations scored significantly higher when compared with static visuals. Moreover when three instructional techniques compared students who received feedback and questioning besides computer animations in addition to only questioning besides computer animations scored significantly higher for the overall test scores from the students who received only use of computer animations. Similar findings were found within the study of Hanrahan (1998) who was searching for the effect of constructivist approach on students' motivation and learning. In the research watching videos were combined with discussions. This was similar to the computer animation and physical modeling integrated social constructivist approach. After watching the computer animation serious of discussions were made within the groups in order to construct the physical model or complete the given task. Moreover after completing the given tasks most of the time classroom discussions were done by the help of questioning of the instructor. That kind of a combination made the material easier to recall when it is compared with straight reading. This was

explained by citing from Baggett (1984) as representatives which were both auditory and visual creates better mental models when it was compared with linguistic information. In the study of Lin (2011) it was also revealed that for increasing understanding about terminology and comprehension it is important to use computer animations with a techniques like feedback and questioning, whereas for identification and drawing usage of only computer animation may create a beneficial difference.

Therefore usage of computer animations was important for creating a significant difference in conceptual understanding of human reproductive system. However this is not just by increasing visualization skills of micro- level and abstract concepts and processes but also by the implementation of the computer animations. Integration of computer animations in an active learning environment with collaborative group work based on discussions to complete a given task was also an important aspect. Also since they were helpful to the instructor in terms of giving space to circulate between groups, instructor had more chance to serve as a facilitator either by giving feedbacks and questioning, which had a role in the difference as well. So to enhance effect of questioning and amount of scaffolding within a social constructivist classroom, usage of computer animations are meaningful.

The next finding was related with the effect of physical modeling and computer animation implemented instruction on students' motivation towards biology. The finding in this study showed that physical modeling and computer animation implemented instruction improve students' motivation towards biology learning more than the traditional group. This result is accurate with the literature since it is a known fact that constructivism increases students' motivation (Campregher, 2011; Choi & Johnson, 2005; Watters & Ginns, 2000; Hanrahan, 1998; Heafner & Friedman, 2008).

The result was also in concordance with the previous finding which was related with same instructional method and its' effect on understanding concepts. According to Wigfield & Wentzel (2007), motivation has great effect on students' achievement in addition to cognitive engagement and conceptual change process. Therefore it was logical to expect an increase in motivational scores within the experimental group which has higher understanding of concepts due to computer simulation and physical modeling integrated social constructivist instruction.

Social world, students' perception about the social experiences, environment, student's aptitudes and prior- achievement were important factors that determines students level of motivation (Credler, 2005). Since environment and social experiences has such an important value, usage of physical modeling and computer animation integrated social constructivist approach had an important effect on increasing students' level of motivation. Study of Campregher (2011) was related with constructivist approach and cooperative learning methodology integrated with Interactive White Board and students' motivation in addition to learning processes and learning styles. It was revealed that usage of such a technique has a positive impact on increasing students' level of motivation. Increase in the concentration and positive attitudes towards the school environment by the technique was shown as a reason for the increase in students' motivation towards learning. As cited from McDaniel (1985) in the study of Holley (1989) usage of small group learning strategies in addition to involving students to act as a role model for others create a supportive relationship. Therefore it is known fact that friendly environment that is constructed by social constructivism increases students' motivation towards biology learning (Williams, 2011). In their study Ilyas, Rawat, Bhatti & Malik (2013) stated that social constructivist approach make students interact with each other. Approach also emphasizes share of ideas in addition to listening others' point of view. Development of social interaction, communication skills and learning collaboratively in a friendly environment were all established by the approach. Therefore it is logical to conclude that such a friendly environment creates an increase in the students' level of motivation. Findings were also in concordance with the study of Hanrahan (1998).

Study was again about the effect of constructivist approach on students' motivation and learning. It was revealed that students viewed the class as positive and described themselves highly motivated. Activities that reinforce positive beliefs and self-direction were important to overcome restricting negative impacts of teacher centered methods of instruction which was something parallel with computer animation and physical modeling integrated social constructivist approach. Questioning is another important aspect of social constructivism (Driscoll, 2005). As cited from McDaniel (1985) in the study of Holley (1989) asking open ended and provoking questions with adequate wait time is an important aspect of motivational strategy as well. Therefore questioning also helped the students to increase their motivational level towards biology learning. Moreover gaining attention of the students by the instructor is another important aspect as cited. In this study this was accomplished by both computer animations and activities that were mainly based on hands on strategies with the construction of physical modeling. Additionally setting clear and positive goals are other aspects that have impacts on creating an increase in level of students' motivation towards learning. This is also in concordance with the social constructivist classroom settings. As revealed from the study of Morrone, Harkness, D'Amrosio & Caulfield (2004) within social constructivist classroom environment, students perceive teacher as he/ she promoted mastery goals. Therefore it can be concluded as physical modeling and computer animation integrated social constructivist approach created an increase in the level of students' motivation towards biology learning.

Challenging students by setting tasks at a moderate level of difficulty enhance student motivation, by making them regularly experience success (Palmer, 2005). This was mainly applied by the group work tasks in physical modeling and computer animation integrated social constructivist approach. Group work activities, which were mainly composed of constructing a physical model, filling in worksheets, role modeling and constructing comparison tables, were designed by considering those aspects. Prompting students by asking questions based on real life and letting students to accomplish the given tasks from computer animations were parallel

activities with these aspects as well. These activities were increasing the meaningfulness of content and tasks which is also important according to Palmer (2005) to enhance students' motivation. Other points that were applied in the experimental group and suggested by Palmer to increase level of students' motivation were usage of variety of different types of activities and tasks, allowing students to be active participants in the lesson and realistic level of choice in activities and task formats; being supportive, facilitator, reassuring and attentive as a teacher in addition to modeling enthusiasm, thinking, dealing with errors, and dealing with challenge; allowing students to work individually or collaboratively in situations that do not encourage competition. Therefore it was normal to reveal such a difference in the motivation level of the two groups.

According to the study of Tuan, et al., (2005) creating active learning strategies is an important aspect of motivation as well. The study of Millis (2012**)** define active learning as students that are doing things and reflecting on what they have accomplish individually or collaboratively in pairs and or groups. Within physical modeling and computer animation integrated social constructivist approach active learning took place mainly by usage of physical models in addition to accomplishing activities like constructing charts collaboratively. Therefore one of the aims of constructing physical models collaboratively in an active learning environment was for increasing students' level of motivation towards leaning. The study of Lazarowitz & Naim (2013) also advised to focus on how to implement physical models to enhance its effectiveness. Creating an active learning environment is the best for such a purpose as in the case of physical modeling and computer animation integrated social constructivist approach by hands on activities (Lazarowitz & Naim, 2013; Sarıkaya, Selvi & Doğan Bora, 2004). By implementing physical models in such a way development in the students' active learning strategies can be observed as in this study. That kind of a development results with an increase in the students' level of motivation towards biology learning as Tuan, et al., (2005) suggested. Moreover from the study Sarıkaya, Selvi & Dogan Bora (2004) it is known that usage of hands on activities within science lessons creates an increase in positive

attitudes of students in addition to the level of motivation of the students. This was also supported by the study of Holley (1989). Within the study it was stated that hands- on activities when compared with traditional methods creates a significant increase in students' level of motivation. As cited from McDaniel (1985) illustrations and personal examples within classroom discussions has an important role in developing an increase in motivation level of the students. This is something parallel with this study since physical models served as illustrators in addition to computer animations.

In the study of Choi & Johnson (2005) related with effect of constructivism integrated with context based video instruction, increase in the level of students' motivation was mainly explained by the increase in the students' attention. It is known that curiosity and interest is one of the aspect of origin and determination of the motivation (Driscoll, 2005). Therefore increase in attention explains increase in motivation (Choi & Johnson, 2005). This is also in concordance with the findings of this study. It is a known fact that computer animations increase students' attention (Lin, 2011). This is done by directing their attention to relevant visual information by the help of the attention cueing and embedded animated pedagogical agents within the animation (Ayres & Paas, 2007). Therefore it can be concluded that by gaining attention computer animations has a role on increasing students' level of motivation towards learning within the approach that was implemented. By providing feedbacks in different formats, and being entertaining (Lin, 2011), computer animations are important aspect of the significant difference between control and experimental group in terms of students' motivation towards biology learning. Besides gaining attention and providing motivation they were also useful by having over knowledge and classifying complex information and events (Daşdemişr, Doymuş, Şimşek & Karaçöp, 2008).

Study of Tuan, et al., (2005) stated self- efficacy, active learning strategies, learning value, performance goals, achievement goals and learning environment stimulation

as factors that determines level of motivation towards learning. SMTSL was developed in their study by considering those aspects as subscale. This is the same for our study as well for SMTBL questionnaire.

When the subscales of the SMTBL questionnaire was investigated SE (self- efficacy) mean scores of the experimental group was higher than the control group. In addition mean score of the experimental group were higher than the midpoint while that was not the case for the control group. This is in concordance with the literature. In the study of Watters & Ginns (2000) it is stated that collaborative learning and authentic learning tasks have a positive effect on students' motivation mainly increasing the self- efficacy of the students. As stated before collaborative learning is one of the main aspects of social constructivism therefore physical modeling and computer animation integrated social constructivist approach.

Other subscale was the ALS (active learning strategies) which was again showed higher mean scores in the experimental group than control group in addition to being higher than the midpoint. It is also supported by the literature, physical modeling increase active engagement of the students in to the lesson (Kindfield, 1992; Lazarowitz & Naim, 2013). Since computer animation and physical modeling integrated social constructivist instruction based on student centered perspective, it is normal to observe such a difference in the active learning strategies.

According to Tuan, Chin & Shieh (2005) problem-solving and thinking and relevance of knowledge to daily life are some factors that highlight the value of learning. Those two factors were important in the instruction model applied in experimental group. The results revealed that mean scores for BLV (Biology Learning Value) subscale was higher in experimental group than control group in addition to being higher than the midpoint.

The results for the performance goals were differing than those of others. There is a slight difference between experimental and control group mean scores in the favor of the control group. This difference can be explained by preventing competition between students in the instructional method that is applied in the experimental group (Fetsco & McClure, 2005). Preventing competition especially during collaborative learning environment is essential for increasing intrinsic motivation of the students (Palmer, 2005). To establish that within the experimental group, teacher served as a facilitator, scaffolder rather than making assessments, critics. Teachers avoided labeling given answers or constructed models as "wrong" or "with mistakes". Role of the instructor was to prompt students in a way to realize their misconceptions on their own by prompting questions, or creating contexts for discussing different conceptions. Therefore such a difference is normal to observe.

Achievement goal subscale of the SMTBL questionnaire revealed same results as the subscales SE, ALS and BLV. Mean score of the experimental group for AG was higher than the control group. This is an expected situation since within the experimental group improvement and challenge were emphasized in addition to creating an environment in which students could experience their improvement (Credler, 2005). Teacher avoided making evaluations in public, in addition to expressing the best and the worst performance. Any type of ordering in terms of students' performances was avoided. Moreover since physical modeling and computer animations increase students' attention and engagement, it is logical to expect an increase in intrinsic motivation.

The last subscale was the learning environment stimulation (LES) related with students perceptions about the learning environment. This includes peer- peer and student- teacher interactions, teaching strategies of the teacher and activities that were applied within the class. There is a slight difference in the mean scores of experimental and control group in the favor of the experimental group. In addition mean score of the experimental group was higher than the midpoint. The difference

between two groups were normal since the variety of the activities like usage of visuals, group working and modeling, were considered in the experimental group. What was surprising was the slight difference. This could be explained by the duration that the computer animation and physical modeling integrated with social constructivist instruction applied, which was only four weeks. The school that this instruction applied was a traditional school. Main visual was transparencies and mostly preferred instructional method was lecturing which is teacher centered. So it is difficult to change students' perceptions about the classroom environment that their teacher created beforehand within a short period. Another explanation according to Tuan, Chin, Tsai & Cheng (2005) is that low LES scores, while having high motivational scores could be due to the fact that their motivation were not influenced by environmental stimulation. Case could be observed with students who emphasize on reading and imaginative way in learning. They prefer concentrating on the learning tasks rather than focusing on people around them.

Another finding was one regarding with the effect of computer animation and physical modeling integrated social constructivist instruction on the students' tendency to have different types of achievement goal orientation. It was expected to create an increase in the mastery oriented achievement goals, in addition to a decrease in the performance oriented achievement goals. On the other hand different results were figured out about the mastery oriented achievement goals.

Learning environments have effects on the personal goals Zimmerman (2000). Moreover desirability of mastery goals and performance goals depends on the achievement setting and the purposes expressed in that settings (Kaplan & Middleton, 2002). As stated before in the study of Morrone, Harkness, D'Amrosio & Caulfield (2004) within a social constructivist classroom settings, instructor perceived by the students as he/ she promoted mastery goals. Therefore within social constructivist instruction integrated with physical modeling and computer animation, instructor settled the purposes towards mastery oriented approach, which was

expected to increase their desirability. As cited in the study from Turner, et al., (2002) main explanation is related with the scaffolding aspect of social constructivism. Since its' aim is to make students understand by helping them, students have a chance to make their knowledge on their own. Such an attitude encourages mastery goals while discouraging avoidance strategies.

For that purposes rather than focusing on grades, natural settings must be related with understanding and mastering the material (Kaplan & Middleton, 2002). Focus on understanding can be enhanced by questioning (Turner, et al., 2002), which was used in the approach as a part of social constructivism (Driscoll, 2005). Asking students to explain their understanding is important in terms of making them feel like teacher believes all can be successful. This attempt also makes the students think about the teacher as he/ she emphasizes learning (Turner, et al., 2002), that is why used in physical modeling and computer animation integrated social constructivist approach. As stated before after completing activities like construction of physical models or charts they were expected to present their material most of the time within the class. Making students active in terms of taking responsibility for their own learning is also an important aspect of social constructivism (Driscoll, 2005).

In addition to avoiding focus on grades, within the collaborative teaching environment competition must be prevented as well as suggested by Credler (2005) to promote mastery oriented achievement goals. This is what has done within the physical modeling and computer animation integrated social constructivist approach and benefit of such an environment was proven by the significant difference between control and experimental group in terms of students' level of motivation. As stated by Credler (2005) within mastery oriented classrooms effort, improvement and challenge are the main aspects. To achieve these focusing on grades during lecturing or usage of ability games with few winners must be prevented. Student participation, which is not focusing on the volunteered students but calling on all students; autonomy by having freedom to talk with others, deciding order in which to compete

the tasks; recognition of students effort with focusing on task; teacher encouragement by warm praises and making students believe that they can complete the given task even if they are struggling are the important aspects of classroom settings to lead students towards mastery oriented goals (Credler, 2005).

Those aspects were all in concordance with the computer animation and physical modeling integrated social constructivist approach. All students were act as active participants throughout the treatment by different activities mainly based on constructing physical modeling. It is also known that social constructivist classroom settings give students autonomy while determining what they have done is whether correct or not (Morrone, Harkness, D'Amrosio & Caulfield, 2004). In such a setting teacher affect became less important. During the construction processes they were the one who needed to decide the correct order about how to construct the model. Moreover after completing their tasks, they were the ones as a group to decide whether they can accomplish the task also by the prompting of the teacher. In addition it is a known fact that social constructivism increases interaction between students and also with the instructor (Summers, 2006). Therefore all have maximum amount of autonomy to talk with each other. That kind of an interaction within collaborative environment can lead to an increase in self-conscious of students which leads to an increase in tendency of having performance goals as revealed in the study. On the other hand Anderman & Anderman (1999) stated that students' perceptions of the task and ability goals emphasized in the classroom setting are important on developing students' personal goals. Social perceptions also have a role in tendency of the type of achievement goal orientation that students have. Enhancement of social responsibility goals increase focus on tasks whereas focus on social goals like forming peer relationships and social status increases self-focus (Anderman& Anderman, 1999). To maintain the focus on social responsibility, social labor was prompted by the instructor as a part of social constructivism (Driscoll, 2005) in addition to preventing competition (Credler, 2005). Besides high amount of interaction within the classroom environment, scaffolding is one of the other important aspects of social constructivism. Therefore recognition of students'

effort with focusing on task and encouragement of teacher by the help of warm praises and making students believe that they can accomplish the task was all regular aspects of the treatment. In such an environment in addition to the attempts of the instructor, computer animations enhanced social constructivism by helping instructor to scaffold the students by giving more time to walk around the groups of students (Rotabin, Marbach- Ad & Stavy, 2007). In the study of Ryan & Patrick (2001), classroom contexts with these properties create engagement in learning.

In addition to these usage of variety of tasks must be considered to lead students to mastery goals (Cuevas, Contreras & Garcia- Calvo, 2012). Variation in assignments, frequent group projects, encouragement of peer assistance and substantive comments on student work were also important to create such an environment (Stipek & Daniels, 1988). Those factors are all in concordance with the physical modeling and computer animation integrated social constructivist instruction.

In this study it is figured out that computer animation and physical modeling integrated with social constructivist approach do not have any effect on students' tendency to have mastery approach goals and mastery avoidance goals. It is in concordance with the mastery avoidance goals since social constructivism, mainly by scaffolding, discourages strategies related with avoidance (Turner, et al., 2002). The results revealed that mean scores of the experimental groups in post tests for mastery approach and mastery avoidance achievement goals were both slightly higher than the control group. However once the pretest scores were used as the covariate, it was shown that there was no significant difference between these groups in terms of having mastery approach and mastery avoidance goals. Result which was similar with the findings of this study in terms of changing tendency of students towards mastery goals figured in the study of Cuevas, Contreras & Garcia- Calvo (2012). Reason of this situation was explained by the duration of the instructional method that was implemented. It was suggested that duration of the instructional method was not enough. The suggestion was logical with our case mainly with the mastery

approach goals. Even if variety of activities, autonomy, encouragement of the teacher on the students, recognition of students, and focus on mastery rather than grades were the main aspects of the computer animation and physical modeling implemented instruction to create an effect on the type of the achievement goal that the students' have, it was for four weeks, which was not long enough. Another explanation can be related with the approach of the school and aim of the students related with university exam. As stated before, school that the experiment conducted was a traditional school, and mostly orients students to performance goals. Moreover university exam of the Turkey was based on normative selections and grades of the students have an important impact on that scale. Therefore even if focus on grading was prevented within the classroom environment, there is still an emphasis on grades from external factors that cannot be controlled well enough mainly by the parents of the students. Thus it was difficult to create an increase in the mastery goals mainly related with the mastery approach goals.

In contrary physical modeling and computer animation integrated with social constructivist instruction has an effect on the tendency to have performance approach and performance avoidance goals. There is a significant difference between experimental and control groups mean scores of the post- test scores, when pre- test scores were used as covariate in the favor of the control group. Therefore experimental groups' tendency to have performance approach and performance avoidance goals were decreased. The result has consistency with the PG results of the SMTBL questionnaire. Therefore even if physical modeling and computer animation integrated social constructivist method did not create any change in the mastery oriented achievement goals, it has on performance goals. This result revealed that the instructional method at least created an environment with low focus on ability perceptions and normative comparison. This finding is accurate with the literature. It is a known fact that there is a relation between motivation and achievement goal (Anderman, et al., 2001). Decline in the students' valuations can be associated with the performance goals. Within our study there is an increase in the students' valuations within the experimental group, therefore it is normal to expect a

decrease in the preference of performance oriented goals. Also preventing competition was the major concern of computer animation and physical modeling integrated with social constructivist approach especially during collaborative learning environment to increase intrinsic motivation of the students (Palmer, 2005). And increase in the intrinsic motivation level of the students was proven by the results of SMTBL questionnaire. Therefore results of performance approach goal are in concordance with the other findings of the study. Moreover as stated before scaffolding which is the main aspect of social constructivism enhanced by computer animations by giving space (Rotabin, Marbach- Ad & Stavy ,2007) and the instructors' attempts within computer animation and physical modeling integrated instruction, discourages avoiding strategies (Turner, et al., 2002). Therefore it is logical to expect a decrease in the tendency to have performance avoidance goals as well.

6.3 Implications

As for the results of the study, observations of teachers and students attended in the study, and comments made by the teachers and students helped the researcher to make the following implications. Both students and teachers like physical modeling and computer animation integrated social constructivist instruction. Teacher enjoys teaching human reproductive system unit.

The physical modeling and computer animation integrated social constructivist instruction produced higher levels of understanding in the reproductive system unit in addition to increasing the motivation level. Even if it did not increase the tendency to have mastery approached goals, it has decreased the tendency to have performance based goals.

Even if results were accurate with the literature, there were some limitations within the study. In order to have a better conclusion the special characteristics of learning styles should be briefly examined. It could be important during designing the groups. Since students take in and process information in different ways, results could be effected by those individual differences.

In order to prevent negative effect of group work, students should be trained about co- operative learning skills. This is an important limitation since the school mostly prefers traditional teaching approaches. They should be aware of sharing information and work, caring for each other, and respecting each other' s ideas. Learning these kinds of skills will help students to share responsibilities within group. Also it is important to make students' accustomed to these kinds of instructional methods in earlier grade levels. Also students only instructed with this method in biology lessons. They were taught with traditional instruction in their other lessons. This caused confusion in students' minds.

Regular classrooms were not good enough in terms of time and place for implementation. It would be better to have more time for researching, discussing and evaluating the task that were given. In this study students had 4 weeks, but this time should be longer than 4 weeks. Moreover regular classrooms do not create the best environment for group work. There should be large places, individual tables and chairs for making groups. In order to create such an environment time was lost in the beginning of each lesson. All these resulted in losing class time and adaptation problems.

Teacher should be more experienced with social constructivist approach. Since school leads teacher in the usage of traditional approaches, teachers should apply social constructivist approach with a different topic to get used to. They should behave as a facilitator and supporter rather than being main source of knowledge.

6.4 Recommendations for Future Research

Several recommendations for future research are presented as follows:

1. The study should be replicated by taking into consideration the negative and positive sides of this study to ensure that all students learn all components of the material for better understanding.
2. This study should be replicated by increasing the number of schools which are participating in order to increase generalizability. Both public and private schools should be included, in addition to consideration of the schools' preferred educational approaches.

3. This study should be replicated by increasing the number of classes in order to increase generalizability.

4. Similar studies should be conducted in other topics of biology classes in all levels.

5. Apart from teaching biology topics, it should be used for other lessons such as physics and chemistry in each level.

6. Studies can be conducted to investigate the long term effects of instruction based on physical modeling and computer animation integrated social constructivist approach on retention of concepts for a longer period of time.

7. Application of the physical modeling and computer animation integrated social constructivist approach should be longer than one month.

8. To have better achievement from the physical modeling and computer animation integrated social constructivist instruction, teachers having more than 10- years of experience should be selected and they should be trained before instruction on implementation procedure.

9. Educators should focus on material that promote involvement of students in their own learning.

10. Similar studies can be conducted with the usage of computer simulations rather than animations within the social constructivist approach on students' understanding, motivation towards biology and tendency of choosing different achievement goal orientation types.

REFERENCES

Akar, H. (2003). *Impact of Constructivist Learning Process on Preservice Teacher Education Students' Performance, Retention and Attitudes.* Doctoral Thesis, Middle East Technical University, Ankara.

Akçay, H., Feyzioğlu, B. & Tüysüz, C. (2003). The Effects of Computer Simulations on Students' Success and Attitudes in Teaching Chemistry. *Kuram ve Uygulamada Eğitim Bilimleri/ Educational Sciences: Theory& Practice,* 3, 20-26.

Aksoy, G. (2013). Effect of Computer Animation Technique on Students' Comprehension of the "Solar System and Beyond" Unit in the Science and Technology Course. *Mevlana International Journal of Education,* 3, 40-46.

Alkhawaldeh, S.A. (2007). Facilitating conceptual change in ninh grade students' understanding of human circulatory system concepts. *Research in Science&Technological Education.* 25 (3), 371-385

Ames, C. & Archer, J. (1987). Mothers' beliefs about the role of ability and effort in school learning. *Journal of educational Psychology*, 79, 409-414.

Anderman, L.H. & Anderman, E.M.(1999). Social Predictors of Changes in Students' Achievement Goal Orientations. *Contemporary Educaiton Psychology,* 24 (1), 21-37.

Anderman, E.M., Eccles, J.S., Yoon, K.S., Roeser, R., Wigfield, A. & Blumenfeld, P. (2001). Learning to value mathematics and reading: Relations to mastery nad performance- oriented instructional practices. *Contemporary Educational Psychology,* 26 (1), 76-95.

Anderman, E.M. & Maehr, M.L. (1994). Motivation and schooling in the middle grades. *Reviewof Educational Research,* 64, 287-309.

Angeli, C. & Valanides, N. (2004) Examining the Effects of Text- Only and Txt-and- Visual Insstructional Materials on the Achievement of Field- Dependent and Field- Independent Learners During Problem- Solving with Modeling Software. *Educational Technology Research &Development.* 52 (4), 23- 36.

Arisoy, N. (2007). *Examining 8th grade students' perception of learning environment of science classrooms in relation to motivational beliefs and attitudes.* Master Thesis, Middle East Technical University, Ankara.

Ayres, P. & Paas, F. (2007). Making instructional animations more effective: A cognitive load approach. *Applied Cognitive Psychology,* 21, 695-700.

Baker, E., McGaw, B. & Peterson, P. (Eds) (2007). *International Encyclopaedia of Education 3rd Edition.* Oxford: Elsevier.

Bandura, A. (1997). *Self- efficacy: The exercise of control.* New York: W. H. Freeman.

Başer, M. (2006). Fostering Conceptual Change by Cognitive Conflict Based Instruction on Students' Understanding of Heat and Temperature Concepts. *Eurasia Journal of Mathematics, Science and Technology Education*, 2, 96- 114.

Başer, M. (2007). *The Cotribution of Learning Motivation, Reasoning Ability and Learning Orientation to Ninth Grade International Baccalaurate and National Program Students' Understanding of Mitosis and Meiosis*. Master Thesis, Middle East Technical University, Ankara.

Bay, E., Bagceci, B. & Cetin, B. (2012). The Effects of Social Constructivit Approach on the Learners' Problem Solving and Metacognitive Levels. *Journal of Social Sciences*, 8 (3), 343-349.

Berlyne, D. (1965). *Structure and Direction in Thinking*. New York: John Wiley and Sons, Inc.

Biehler, R.F. & Snowman, J. (1997). *Psychology applied to teaching.* Boston. New York: Houghton Mifflin Company.

Boekaerts, M. (1999). Self-regulated learning: Where we are today. *International Journal of Educational Research*, 31, 445-457.

Bogiages, C. & Hitt, A.M. (2008). Student make stop- animation films to illustrate the process of mitosis. *The Science Teacher,*75 (9), 36-43.

Bonwell, C.C. & Eison, J.A. (1991). *Active Learning: Creating Excitement in the Classroom. ASHE-ERIC Higher Education Report No.1.* Washington, DC: George Washington University.

Bredo, E. (1994). Reconstructing educational psychology: Situated cognition and Deweyian pragmatism. *Educational Psychologist,* 29 (1), 23-25.

Brown, C.R. (1990). Some Misconceptions in Meiosis Shown by Students Responding to an Advanced Level Practical Examination Question in Biology. *Journal of Biological Education.* 24 (3), 182-186.

Bruner, J.S. (1966). *Toward a theory of instruction. Cambridge.* MA: Belknap Press.

Campbell, M.A., Reece J.B., Taylor R.M. & Simon E.J. (2006). *Biology concepts and connections*. San Fransisco: Pearson Education.

Campregher, S. (2011). *Effects of the Interactive Whiteboard (IWB) in the Classroom Experimental Research in Primary School,* Paper presented in the first International conference of The Future Educaiton, June 16- 17. Florence, Italy.

Carey, S. (1985). *Conceptual change in childhood.* Cambridge, MA: MIT Press.

Carpenter, S.L. (2007). *A Comparison of the relationships of Students' Self- Efficacy, goal orientation, and achievement across grade levels: A Meta- Analysis.* Master Thesis, Simon Fraser University, Canada.

Cavallo, A.M.L., Potter, W.H. & Rozman, M. (2004). Gender differences in learning constructs, shifts in learning constructs, and their relationship to course achievement in a structured inquiry, yearlong physics course for life science majors. *School Science and Mathematics,* 104, 288-300.

Chinnici, J., Neth, S. & Sherman, L. (2006). "Chromosomal Socks" To Demonstrate Ploidy in Mitosis& Meiosis. *The American Biology Teacher.* 68 (2), 106-109.

Choi, H.J. & Johnson, S.D. (2005). The Effect of Context- Based Video Instruction on Learning and Motivation in Online Courses. *The American Journal of Distance Education,* 19 (4), 215-227.

Clark, D.C. & Mathis, P.M. (2000). Modeling Mitosis & Meiosis, A Problem-Solving Activity. *The American Biology Teacher,* 62, 204-206.

Coştu, B., Ayas, A., Niaz, M., Ünal, S. & Çalik, M. (2007). Facilitating Conceptual Change in Students' Understanding of Boiling Concept. *Journal of Science EducationTechnolog,* 16, 524-536.

Credler, M.E. (2005). *Learning and Instruction: Theory and Instruction.* Upper Saddle River, NJ: Pearson Education, Inc.

Cuevas, R., Contreras, O. & Garcia- Calvo, T. (2012). Effects of an experimental program to improve the motivation in physical education of Spanish students. *Procedia- Social and Behavioral Sciences,* 47, 734-738.

Çakır, O.S., Geban, Ö. & Yuruk, N. (2002). Effectiveness of conceptual change text-oriented instruction on students' understanding of cellular respiration concepts. *Biochemistry and Molecular Biology Education,* 30(4), 229-243.

Çetin, G. (2003). *The Effect of Conceptual Change Instruction on Understanding of Ecological Concepts.* Doctoral Thesis, Middle East Technical University, Ankara.

Daşdemir, İ., Doymuş, K., Şimşek, Ü. & Karaçöp, A. (2008). The Effects of Animation Technique on Teaching of Acids and Bases Topics. *Journal of Turkish Science Education,* 5, 60-69.

Deci, E.L. & Ryan, R.M. (1985). *Intrinsic motivation and self- determination in human behavior.* New York: Plenum.

Deci, E.L. & Ryan, R.M. (2000). The ‘‘what’’ and the ‘‘why’’ of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry,* 11 (4), 227-268.

Deemer, S.A. (2004). Using achievement goal theory to translate psychological principles into practice in the secondary classroom. *American Secondary Education,* 32 (3), 4-16.

Demircioğlu, H. & Geban, Ö. (1996). Fen Bilgisi Öğretiminde Bilgisayar Destekli Öğretim ve Geleneksel Problem Çözme Etkinliklerinin Ders Başarısı Bakımından Karşılaştırılması. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi,* 12, 183-185.

Dignath, C., Buettner, G. & Langfeldt, H. (2008). How can primary school students learn self- regulated learning strategies most effectively? A meta- analysis on self-regulation training programmes. *Educational Research Review,* 3, 101-129.

Dikmenli, M. (2010). Misconceptions of cell division held by student teachers in biology: A drawing analysis. *Scientific Research and Essays,* 5 (2), 235-247.

Dinger, F.C., Dickhäuser, O., Birgit, S. & Ricarda, S. (2013). Antecedents and consequences of students' achievement goals: A mediation analysis. *Learning % Individual Differences,* 28, 90-101.

Doolittle, P.E. (1999). *Constructivism and Online Education.* Virginia Polytechic Institute& State University.

Driscoll, M.P. (2005). *Psychology of Learning for Instruction*. Third Edition, Toronto, ON: Pearson.

Driver, R. & Easley, J. (1978). Pupils and paradigms: A review of literature related to concept development in adolescent science students. *Studies in Science Education*, 5, 61-84.

Duffy, M.T. & Jonassen, D.H. (1992). *Constructivism and the Technology of Instruction: A Conversation.* USA: Lawrence Erlbaum Associates.

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*, June 26-28. Turku, Finland.

Duit, R. (1991). *Bibliography: Research on students alternative frameworks in science-topics, theoretical frameworks, consequences for science teaching.* Kiel, Germany, IPN.

Elliot, A.J. (1999). Approach and Avoidance Motivation and Achievement Goals. *Educational Psychologist*, 34, 169-189.

Elliot, S.N., Kratochwill, T.R., Littlefield, J. & Travers, J.F. (2000). *Educational physchology; effective teaching, effective learning.* United States of America: McGraw Hill.

Elliot, A.J. & McGregor, H.A. (2001). A2 x A2 Achievement Goal Framework. *Journal of Personality and Social Psychology,* 80 (3), 501-519.

Fetsco, T. & McClure, J. (2005). *Educational psychology: an integrated approach to classroom decisions.* New York: Pearson Education Inc.

Flannery, M. C. (1999). At home in the cell. *American Biology Teacher*, 61 (1), 64-68.

Finney, S.J., Pieper, S.L. & Barron, K.E. (2004). Examining the Psychometric Properties of the Achievement Goal Questionnaire in a General Academic Context. *Educational and Psychological Measurement.* 64, 365-382.

Flores, F. (2003). Representation of the cell and its processes in high school students: an integrated view, *International Journal of Science Education.* 25 (2), 269-286.

Gardner, H. (1983). *Frames of Mind: The Theory of Multiple Intelligences*. Basic Books, Cambridge.

Gardner, J. & Belland, B. (2012). A Conceptual Framework for Organizing Active Learning Experiences in Biology Instruction. *Journal of Science Education & Technology*, 21, 465.

Gilbert, J.K., Justi, R. & Aksela, M. (2003). The visualization of models: A metacognitive competence in the learning of chemistry. Paper presented at the *4th Annual Meeting of the European Science Education Research Association*, Noordwijkerhout, The Netherlands.

Glasersfeld, E. (1995). *Radical Constructivism A Way of Knowin.*, London: The Falmer Press.

Goldin, G. & Shteingold, N. (2001). *Systems of representations and the development of mathematical concepts. In A. Cuoco & F. R. Curcio (Eds.), The roles of representation in school mathematics: 2001 Yearbook (pp. 1–23).* Reston, VA: National Council of Teachers of Mathematics.

Goldman, R. & Goldman, J. D. (1982). How children perceive the origin of babies and the roles of mothers and fathers in procreation: A cross-national study. *Child Development.* 53, 491-504.

Gordin, D.N. & Pea, R.D. (1995). Prospects for Scientific Visualization as an Educational Technology. *Journal of the Learning Sciences,* 4 (3), 249-279.

Gott, R., Schofield, B., Davey, A., Gamble, R., Head, J., Khaligh, N., Murphy, P., Orgee, T. & Welford, G. (1985). *Science in Schools Ages 13 and 15, Report No. 3.* London: APU.

Hackling, M.W. & Treagust, D.F. (1982). What lower secondary students should understand about the mechanisms of inheritance, and what they do understand following instruction. *Research in Science Education,* 12, 78-88.

Hanrahan, M. (1998). The effect of learning environment factors on students' motivation and learning. *International Journal of Science Education,* 20 (6), 737-753.

Hardre, P. L., Chen, C.m Huang, S., Chiang, C., Jen, F. & Warden, L. (2006). Factors Affecting High School Students Academic Motivation in Taiwan. *Asia Pacific Journal of Education,* 26 (2), 189-207.

Haqq, A. & Ismat B. (1998). Constructivism in Teacher Education: Considerations for Those Who Would Link Practice to Theory. *ERIC Clearinghouse on Teaching and Teacher Education.*

Heafner, T.L. & Friedman, A.M. (2008). Wikis and Constructivism in Secondary Social Studies: Fostering a Deeper Understanding. *Computer in the Schools*, 25 (3-4), 288-302.

Hewson, P.W. (1992). *Conceptual Change in Science Education Teaching and Teacher Education*, University of Wisconsin- Madison, United States of America.

Holley, D.R. (1989). Developing Laboratory Activities to Increase Student Motivation in Earth Science. *UNF Theses and Dissertations*. Paper 40. http://digitalcommons.unf.edu/etd/40 (last accessed on 28.12.2014)

Hsu, Y& Thomas, R. A. (2002). The impacts of a web- aided instructional simulation on science learning. *International Journal of Science Education.* 24 (9), 955-979.

Huppert, J., Lomarsk, S.M. & Lazarowitz, R. (2002). Computer simulations in the high school: students' cognitive stages, science process skills and academic achievement in microbiology. *International Journal of Science Education*, 24 (8), 803-821.

Ilyas, B.M., Rawat, K.J., Bhatti, M.T. & Malik, N. (2013). Effects of Teaching of Algebra through Social Constructivist Approach on 7th Graders' Learning Outcomes in Sindh (Pakistan). *International Journal of Instruction*, 6, 151-164.

Kaplan, A. & Maehr, M.L. (1999). Enhancing the motivation of African American students: An achievement goal theory perspective. *The Journal of Negro Education*, 68, 23-42.

Kaplan, A. & Maehr, M.L. (2007). The Contributions and Prospects of Goal Orientation Theory. *Educational Psychology Review*, 19, 141-184.

Kaplan, A. & Middleton, M.J. (2002). Should childhood be a journey or a race? *Journal of Educational Psychology*, 94, 646-648.

Keiny, S. (2008). "Conceptual change'' as both revolutionary and evolutionary process'. *Teachers and Teaching*, 14, 61-72.

Kiboss, K.J., Ndirangu, M. & Wekesa, E.W. (2004). Effectiveness of a Computer Mediated Simulations Program in School Biology on Pupils' Learning Outcomes in Cell Theory. *Journal of Science Education and Technology.* 13 (2), 207-213.

Kim, P. (2006). Effects of 3D Virtual Reality of Plate Tectonics on Fifth Grade Students' Achievement and Attitude toward Science. *Interactive Learning Environments.* 14 (1), 22-34.

Kindfield, A.C.H. (1992). *In teaching genetics; Recommendations and research proceeding of national conference.* Smith M.U-Simons PE, 39-43,Cambridge.

Kizilgunes, B., Tekkaya, C. & Sungur, S. (2009). Modeling the relations among students' epistemological beliefs, motivation, learning approach, and achievement. *The Journal of Education Research*, 102 (4), 243-255.

Köksal, M.S. (2012). Adaptation Study of Motivation Toward Science Learning Questionnaire for Academically Advanced Science Students. *Chemistry: Bulgarian Journal of Science Education*, 21(1), 29-44.

Küçükahmet, L. (2000). *Öğretimde Planlama ve Değerlendirme*. Ankara: Nobel Yayın Dağıtım. 11.Baskı.

Lazarowitz, R.& Naim, R. (2013). Learning the Cell Structures with Three-Dimensional Models: Students' Achievement by Methods, Type of School and Questions' Cognitive Level. *Journal of Science Education and Technology,* 22 (4), 500-508.

Lewis, J. & Kattman, U. (2004). Traits, genes, particles and information: re-visiting students' understanding of genetics. *International Journal of Science Education.,* 26 (2), 195-206.

Lin, H. (2011). Facilitating Learning from Animated Instruction: Effectiveness of Questions and Feedback as Attention- directing Strategies. *Educational Technology& Society,* 14, 31-42.

Lock, R. (1997). Post-16 Biology-Some Model Approaches?. *School Science Review*. 79, 33-39.

Locke, J. & McDermid, H.E. (2005). Using Pool Noodles to Teach Mitosis and Meiosis *Innovations in Teaching and Learning Genetics,* 170, 5-6.

Malacinski, G.M. & Zell, P.W. (1996). Manipulating the "invisible". Learning molecular biology using inexpensive models. *The American Biology Teacher,* 58, 428-432.

Marshall, H. (1996). Clarifying and implementing contemporary psychological processes. *Educational Psychologist,* 31 (1), 29-34.

Martin, D.J. (2006). *Elementary Science Methods A constructivist Approach.* USA: Thomson Wadsworth.

McCormick, C.S. (2007). *Use of Dendrochronology to Promote Understanding of Environmental Change.* Doctoral Thesis, University of Louisiana State,

Middleton, M. & Midgley, C. (1997). Avoiding the demonstration of lack of ability: An underexplored aspect of goal theory. *Journal of Educational Psychology,* 89, 710-718.

Millis, B.J. (2012). Active Learning Strategies in Face to Face Courses, *The Idea Paper No: 53.* Available online at http://www.theideacenter.org/sites/default/files/paperidea_53.pdf (last accessed on 28.12.2014)

Morrone, A.S., Harkness, S.S., D'Ambrosio, B. & Caulfield, R. (2004). Patterns of Instructional Discourse that Promote the Perception of Mastery Goals in a Social Constructivist Mathematics Course. *Educational Studies in Mathematics,* 56 (1), 19-38.

Nicholls, J. (1989). *The competitive ethos and democratic education.* Cambridge, MA: Harvard University Press.

Nien, C. & Duda, J.L. (2008). Antecedents and consequences of approach and avoidance achievement goals: A test of gender invariance. *Psychology of Sport and Exercise,* 9 (3), 352-372.

Ormrod, J. E. (2006). *Educational Psychology: Developing Learners.* Upper Saddle River, N.J: Pearson.

Öztap, H., Özay, E. & Öztap, F. (2003). Teaching cell division to secondary school students: an investigation of difficulties experienced by Turkish teachers, *Journal of Biological Education.* 38 (1), 13-15.

Pallant, J. (2007). *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS for Windows.* Berkshire: McGraw Hill, Open University Press.

Palmer, D. (2005). A Motivational View of Constructivist- informed Teaching. *Internal Journal of Science Education,* 27, 1853- 1881.

Patrick, H. (2002). The classroom environment and students' reports of avoidance behaviors in mathematics: A multi-method study. *Journal of Educational Psychology,* 94, 88-106.

Pintrich, P.R. (1999). The role of motivation in promoting and sustaining self-regulated learning. *International Journal of Educational Research,* 31, 459- 470.

Pintrich, P.R. (2000). The role of goal orientation in self-regulated learning. In M. Boekaerts, P. R. Pintrich, and M Zeidner (Eds.). *Handbook of self-regulation* (pp. 451-502). New York: Academic Press.

Pintrich, P. & Schunk D. (2002). *Motivation in education: Theory, research and applications.* New Jersey: Prentice-Hall.

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 (2), 211-227.

Pulkka, A. & Niemivirta, M. (2013). Adult Students' Achivement Goal Orientations and Evaluations of the Learning Environment: A Person- Centred Longitudinal Analysis. *Educational Research and Evaluation,* 19, 297-322.

Quinn, F., Pegg, J. & Panizzon, D. (2009). First-year biology students understandings of meiosis: an investigation using a structural theoretical framework. *International Journal of Science Education*, 31 (10), 1279-1305.

Riever, L. (2000). *Getting interactive with Authorwave: Building simulations and games,* Madison. WI: Brown and Benchmark.

Ross, A. & Willson, V. (2012). The Effects of Representations, Constructivist Approaches, and Engagement on Middle School Students' Algebraic Procedure and Conceptual Understanding. *School Science and Mathematics,* 112, 117-128.

Rotbain, Y., Marbach- Ad, G. & Stavy, R. (2006). Effects of Bead and Illustrations Models on High School Students' Achievement in Molecular Genetics. *Journal of Research in Science Teaching.* 43 (5), 500-529.

Rotbain, Y., Marbach-Ad, G. and Stavy, R. (2007). Using a Computer Animation to Teach High School Molecular Biology. *Journal of Science Education and Technology*. 17, 49-58.

Rotter, J. (1966). Generalized expectancies for internal versus external control of reinforcements. *Psychological Monographs*. 80, 1-28.

Ryan, A.M. & Patrick, H. (2001). The Classroom Social Environment and Changes in Adolescents' Motivation and Engagement During Middle School. *American Educational Research Journal,* 38 (2), 437-460.

Salili, F. & Lai, M.K. (2003). Learning and motivation of chinese student in Hong Kong : A longitudinal study of contextual influences on students' achievment orientations and performance. *Psychology In The Schools*, 40 (1), 51-70.

Sanger, M.J., Brecheisen, D.M. & Hynek, M.B. (2001). Can Computer Animations Affect College Biology Students' Conceptions About Diffusion & Osmosis?. *The American Biology Teacher*, 63, 104-109.

Saral, S. (2008). *The Effect of Case Based Learning on Tenth Grade Student's Understanding of Human Reproductive System and Their Perceived Motivation.* Master Thesis, Middle East Technical University, Ankara.

Sarıkaya, R., Selvi, M. & Doğan Bora, N. (2004). Mitoz ve Mayoz Konularının Öğretiminde Model Kullanımının Önemi. *Kastamonu Eğitim Dergisi,* 12, 85-88.

Schraer, W.D. & Staltze, H.J. (1995). *Biology The Study of Life*. USA: Prentice-Hall.

Skaalvik, E.M. & Skaalvik, S. (2013). School goal structure: Associations with students' perceptions of their teachers as emotionally supportive, academic self-concept, intrinsic motivation, effort, and help seeking behavior. *International Journal of Educational Research*, 61, 5-14.

Smith, M. (1991). Teaching Cell Division: Student difficulties and teaching recommendations. *Journal of College Science Teaching.* 21, 28-33.

Smith, L.E., Blakeslee, T.D.,& Anderson, C.W. (1993) Teaching strategies associated with conceptual change learning in science. *Journal of Research in Science Teaching,* 30, 111-126.

Stewart, J., & Dale, M. (1989). High school students' understanding of chromosome/gene behaviour during meiosis. *Science Education,* 73(4), 501-521.

Stewart, J., Hafner, B. & Dale,M. (1990). Students' Alternate Views of Meiosis. *The American Biology Teacher,* 52 (4), 228-232.

Stipek, D.J. & Daniels, D.H. (1988). Declining perceptions of competence: A consequence of changes in the child or in the educational environment?. *Journal of Educational Psychology*, 80, 352-356.

Stravroulakis, A.M. (2005). Meio- Socks & Other Genetics Yarns. *American Biology Teacher,* 67 (4), 233-238.

Summers, J.J. (2006). Effects of Collaborative Learning in Math on Sixth Graders' Individual Goal Orientations from a Socioconstructivist Perspective. *Elementary School Journal,* 106(3), 273-290.

Sungur, S. (2004). *An Implementation of Problem Based Learning in High School Biology Courses.*Doctoral Degree, Middle East Technical University, Ankara.

Sungur, S., Tekkaya, C. & Geban, O. (2006) Improving achievement through problem- based learning. *Journal of Biological Education,* 40 (4), 155-160.

Tanel, R., Şengören, S.K. ve Kavcar, N. (2006). The Effect of Using the Cooperative Learnings Strategies on Students' Conceptual Change for the Subject of Mechanical Waves, *Paper presented in the 6th International Conference of the Balkan Physical Union,* August 22-26. İstanbul: Turkey.

Templin, A.T. & Fetters, M.K. (2002). Meselson- Stahl experimental simulation using Lego ™ uilding blocks. *The American Biology Teacher,* 64, 613-619.

The Umass Scientific Reasoning Research Institute. (2008), Constructivism and science education.
http://srri.umass.edu/topics/constructivism (last accessed 28.12.2014)

Trindade, J., Fiolhais, C. & Almedia, L. (2002). Science learning in virtual environments: a descriptive study. *British Journal of Educational Technology,* 33, 1-18.

Tuan, H., Chin, C. & Shieh, S. (2005). The development of a questionnaire to measure students' motivation towards science learning. *International Journal of Science Education,* 27, 634-659.

Tuan, H., Chin, C., Tsai, C. & Chang, S. (2005). Investigating the Effectiveness of Inquiry Instruction on the Motivation of Different Learning Styles Students. *International Journal of Science and Mathematics Educaiton,* 3, 541- 566.

Turner, J.C., Midgley, C., Meyer, D.K., Gheen, M., Anderman, E.M., Kang, J. &

Turner, J.C. (2002). 'Creating mastery-oriented mathematics classrooms in an urban middle school: One teacher's strategies', in T. Urdan (Chair), Exploring Patterns of Adaptive Learning: Studies inspired by Carol Midgley, *symposium conducted at the annual meeting of the American Psychological Association,* Chicago, IL, August 2002.

University of Georgia Biosciences (2001), Cell Division: Meiosis and Sexual Reproduction.
http://ridge.icu.ac.jp/biobk/BioBookmeiosis.html (last accessed 28.12.2014)

Uzuntiryaki, E. (2003). Constructivist approach: Removing misconceptions about chemical bonding. *Paper presented at the annual meeting of the National Association for Research in Science Teaching* (Philadelphia, Pennsylvania, March 23Y26).

Watters, J.J. & Ginns, I.S. (2000). Developing motivation to teach elementary science: Effect of collaborative and authentic learning practices in preservice education. *Journal of Science Teacher Educaiton,* 11 (4), 277-313.

Weiss, R.E., Knowlton, D.S & Morrison, G. R. (2002). Principles For Using Animation in Computer Based Instruction: Theoretical Heuristics for Effective Design. *Computers in Human Behaviour,* 18, 465-477.

West, C. (2013). Motivating Music Students: A Review of the Literature. *Update Applications of Research in Music Education,* 31, 11-19.

Wigfield, A., & Wentzel, K.R. (2007). Introduction to motivation at school: Interventions that work. *Educational Psychologist,* 42 (4), 191-196.

Williams, G. (2002). *Biology for You Support Pack.* United Kingdom: Nelson Thornes Ltd.

Williams, J. G. (2011). *The Effects of Using Constructivism in the High School Science Classroom,* Master Thesis, Montana State University, Bozeman.

Williamson, V.M. & Abraham, M.R. (1995). The effects of computer animation on the particulate mental models of college chemistry students. *Journal of Research in Science Teaching,* 32 (5), 521- 534.

Windschitl, M.A. (1998). A practical guide for incorporating computerbased simulations into science instruction. *The American Biology Teacher,* 60, 92-97.

Winnie, P.H. (1995). Inherent Details in Self- Regulated Learning. *Educational Psychologist,* 30, 173-187.

Wu, Y. & Tsai, C. (2005). Effects of constructivist- oriented instruction on elementary school students' cognitive structures. *Journal of Biological Education,* 39, 113-119.

Wynne, C.F., Stewart J. & Passmore C. (2001). High school students' use of meiosis when solving genetics problem. *International Journal of Science Education,* 23 (5), 501-515.

Xiang, P., McBride, R. & Solmon, M.A. (2003). Motivational climates in ten teachers' elementaryphysical education classes: An achievement goal theory approach. *The Elementary School Journal,* 104 (1), 71-92.

Veiga, L., Teixeira, F., Martins, I. & Maliço-Silvestre, A. (2006). Sexuality and human reproduction: a study of scientific knowledge, behaviors and beliefs of Portuguese future elementary school teachers. *Sex Education,* 6 (1), 17-29.

Vogel, J.J., Ericksen, A., Bowers, J.C. & Bowers, C.A. (2006). Using virtual Reality with and without Gaming Attributes for Academic Achievement. *Journal of Research on Technology in Education.* 39 (1), 105-118.

Yakışan, M., Yel, M. & Mutlu, M. (2009). Biyoloji Öğretiminde Bilgisayar Animasyonlarının Kullanılmasının Öğrenci Başarısı Üzerine Etkisi. *Kırşehir Eğitim Fakültesi Dergisi,* 10, 129-139.

Yeter, B. (2010). *Effects of 7E Learning Cycle Model Accompanied with Computer Animaitons on Understanding of Diffusion and Osmosis Concepts*, Doctoral Thesis, Middle East Technical University, Ankara.

Young Blood Biology. (2011), The Process of Meiosis. http://youngbloodbiology.wikispaces.com/The+process+of+Meiosis (last accessed on 28.12.2014)

Zimmerman, B. J. (2000). *Attaining self- regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), Handbook of self- regulation (pp. 13- 40).* San Diego, CA: Academic.

Zull, J. E. (2011). *From brain to mind: Using neuroscience to guide change in education.* Sterling, VA: Stylus Publishing.

APPENDIX A

HUMAN REPRODUCTIVE SYSTEM CONCEPTUAL TEST

This test was designed to test your academic achievement on the subject of Human Reproduction. It is composed of four pages and contains 21 multiple choice items. Choose the most appropriate item and circle. Duration of the test is 45 minutes.

Figure1:

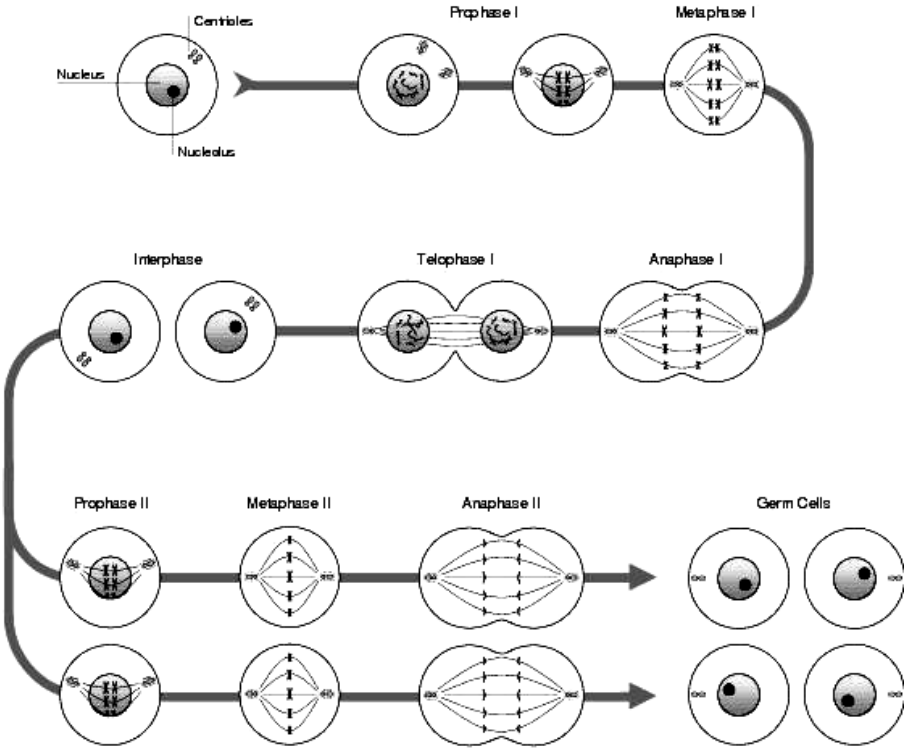
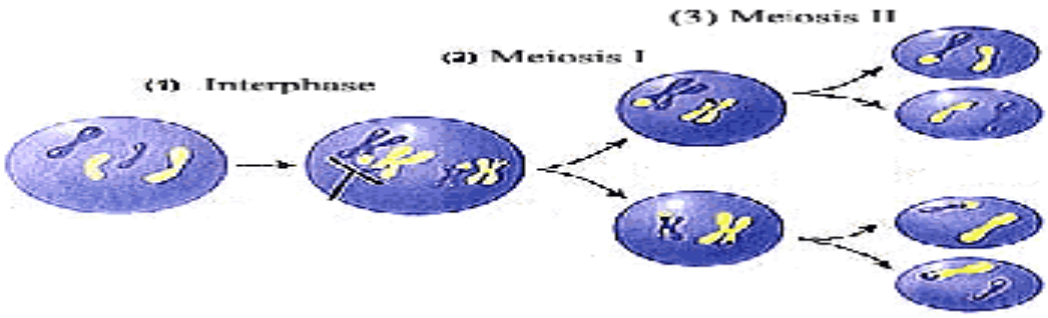


Figure 2:



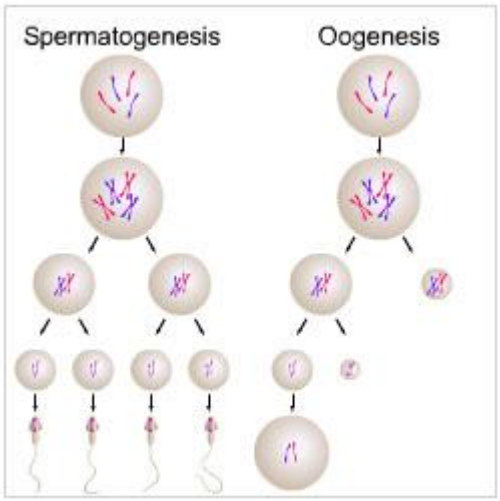
Two of the figure above represent the phases of meiosis. Answer the following questions 1-7 according to the figures.

1. **Which one of the following is true for meiosis?**
   - **a)** A chromosome has always two chromatids during cell division
   - **b)** A chromosome always have 4 chromatids during cell division
   - **c)** A chromosome have always 2 centromere during cell division
   - **d)** A chromosome have 4 centromeres during cell division
   - **e)** A chromosome have homologous chromosome as a pair.
2. **Which one of the following is correct for spindle fibers,**
   - **a)** Spindle fibers are formed from centromere
   - **b)** Spindle are formed within the nucleus
   - **c)** Spindle fibers are formed by the help of chromosomes
   - **d)** Spindle fibers are formed by centriole
   - **e)** Spindle fibers are formed in the middle of the meiosis
3. **In between which stages of meiosis chromosome number decrease into half?**
   - **a)** Prophase1- Metaphase1
   - **b)** Metaphase2- Anaphase2
   - **c)** Telophase1- Prophase2
   - **d)** Anaphase2-Telophase2
   - **e)** Telophase2-Interphase1
4. **In which stage of meiosis spindle fibers and chromosomes are formed?**
   - **a)** Prophase1
   - **b)** Anaphase2
   - **c)** Metaphase1
   - **d)** Telophase2
   - **e)** Interphase2
5. **In which phase of meiosis crossing over takes place?**
   - **a)** Metaphase1
   - **b)** Anaphase1
   - **c)** Telophase1
   - **d)** Metaphase2
   - **e)** Anaphase2

6. **In which phase of meiosis homologous chromosomes separate from each other?**
   - **a)** Metaphase1
   - **b)** Anaphase2
   - **c)** Telophase1
   - **d)** Metaphase2
   - **e)** Anaphase1
7. **If 2n=8 in the beginning of spermatogenesis what would be the chromosome number of sperm cells?**
   - **a)** 2n=8
   - **b)** n=8
   - **c)** n=4
   - **d)** 2n=4
   - **e)** 2n=6

Answer the following questions 8-9 according to the figure below

.



8. **In the end of spermatogenesis how many spermatids are produced?**
   a) 2 **b)** 4 **c)** 6 **d)** 8 **e)**10
9. **Two cells with same chromosome number are getting into oogenesis and meiosis will differ in terms of…….**
   - **a)** Number of cells that are produced at the end

b) Number of chromosome of the cells that are produced at the end

c) Number of the homologous chromosomes that are present during cell division

d) Number of the centrioles that are present during cell division

e) Number of the tetrads that are present during cell division

10. What type of cells are reproduced from male and female reproductive organs?

a) Genetically different cells with half as much genetic information as a body cell

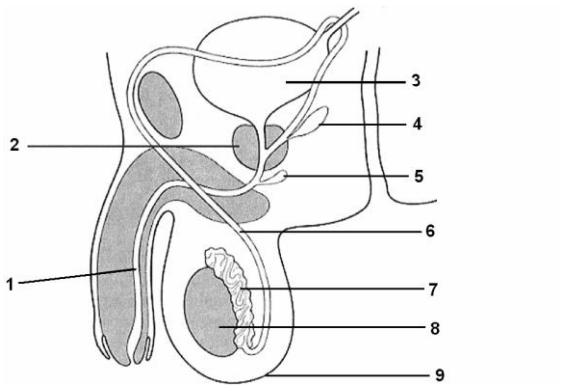
b) Genetically different cells with same amount of genetic information as a body cell

c) Genetically identical cells with half as much genetic information as a body cell

d) Genetically identical cells with same amount of genetic information as a body cell

e) Genetically identical cells with different amounts of genetic information

Figure below shows the male reproductive system. Answer the questions 11-13 according to this figure.



11. State the name of the structure that produces sperm.

a) 1 **b)** 6 **c)** 7 **d)** 8 **e)** 9

12. State the name of the structure that is used both reproductive system and excretory system.

a) 1 **b)** 3 **c)** 4 **d)** 5 **e)**9

13. Removal of the structure 8 prior to puberty would……

a) stimulate development of secondary sexual characteristics

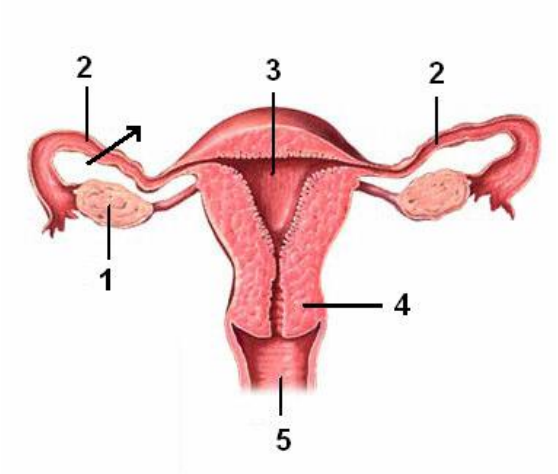
b) prevent proper urinary function

c) stimulate sperm production

d) prevent sexual maturity

e) stimulate testesterone secretion

Use the below diagram of female reproductive system to answer the questions 14-15.



14. If the structure 2 were cut or tied off at the arrow what would have happened?

a) Eggs would not reach to uterus

b) The corpus luteum could not produce progesterone

c) Thickness of uterine wall could not be increased

d) A pregnancy in progress would be disrupted

e) Eggs could not be produced

15. State the label of the part where human embryo implants in.

a) 1 **b)** 2 **c)** 3 **d)** 4 **e)** 5

16. Why it is necessary for sperms to be produced in large numbers when only one sperm cell is required to bring about fertilization?

I. The temperature of the female body is not suitable for sperms to live for a long period of time.

II. Many of the sperms die when they are moving through female reproductive canal.

III. Sometimes pH of the female reproductive canal may not be suitable for the sperms.

a) I only

b) II only

c) I and III only

d) II and III only

e) I, II and III

17. State the parts that are responsible for controlling the hormone levels in menstrual cycle.

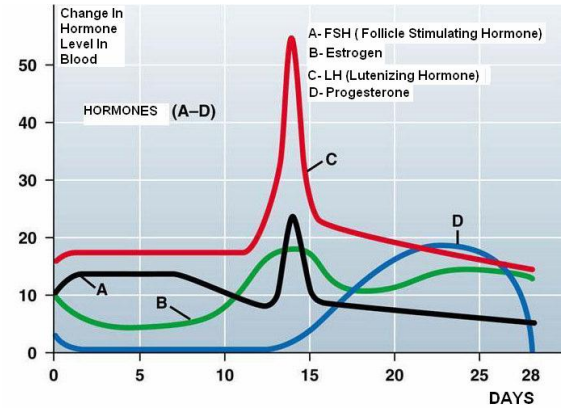
a) Pituitary and ovaries

b) Ovaries only

c) Placenta onlly

d) Uterus and ovaries

e) Ovaries, pituitary and hypothalamus



The graph represents the human menstrual cycle. The amounts of four hormones on the graph are plotted: estrogen, progesterone, FSH and LH. Answer the following question number 18 according to the figure.

18. In this cycle the release of an egg to the oviduct occurs……..

a) between 5th and 10th day

b) between 16th and 26th day

c) between 1st and 7th day

d) between 14th and 16th day

e) on the 28th day

19. When pituitary gland is removed from immature female rabbits, their ovaries do not develop normally. When the pituitary gland is removed from mature rabbits, the ovaries and uterus stop functioning. What do these observations indicate?

a) The ovaries influence uterus.

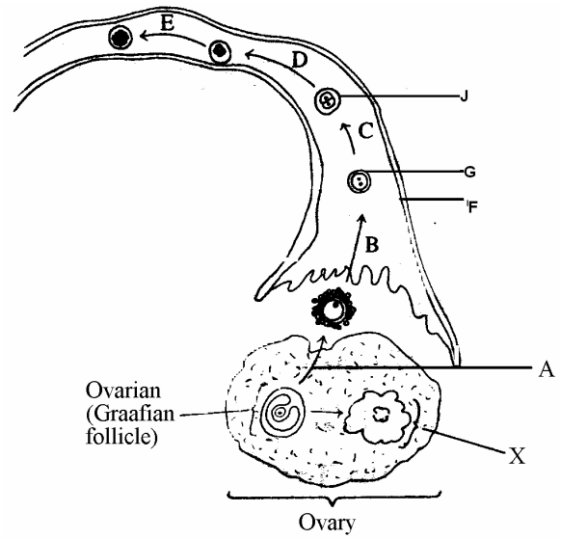
b) The pituitary gland influences both the ovaries and the uterus

c) The ovaries and uterus influence the pituitary gland

d) There is a feedback of hormones from the ovary to the pituitary gland

e) The uterus influences the ovaries

The diagram below shows some of the events which take place in the ovary and the oviduct (fallopian tube) around the time of fertilisation. Use the following diagram to answer the questio 20-21



20. Which structure is responsible for secretion of progesterone during early pregnancy, before the development of placenta?

a) Follicle

b) Structure X

c) Embryo

d) Uterine wall

e) Fallopian tube

21. Which one is the part of female reproductive system where fertilization took place?

a) Ovary

b) Structure X

c) Structure F

d) Structure G

e) Structure J

22. If sperms are present in female reproductive system, which of the followings describe the situation when chance of fertilization is the highest?

a) When egg is in a fallopian tube

b) When a woman is menstruating

c) When progesterone level is increasing

d) When estrogen and progesterone are decreasing suddenly

e) When zygote is already present in the fallopian tubule

23. Which one of the following is true if menstruation occurs?

I. Uterine lining thickens

II. Estrogen level falls

III. Progesterone level falls

IV. Egg is fertilized

a) Only IV

b) I and II

c) II and III

d) II, III and IV

e) III and IV

24. State the name of the hormone that is responsible for producing testosterone in male reproductive system.

a) FSH

b) LH

c) Androgen

d) TSH

e) Estrogen

25. State the name of the parts which are responsible for controlling hormone levels in male reproductive system.

a) Pituitary and testes

b) Testes only

c) Scrotum only

d) Epididymis and testes

e) Prostate gland

26. Which of the followings are required for fertilization to occur inside the female body?

I. Sperm must swim into one of the Fallopian tube (oviduct)

II. An egg must be present in the fallopian tube.

III. The nucleus of a sperm must enter the egg cell.

a) II only

b) III only

c) II and III only

d) I and II only

e) I, II and III

APPENDIX B

ÖĞRENCİLERİN BİYOLOJİ ÖĞRENİMİNE YÖNELİK MOTİVASYONU ANKETİ

AÇIKLAMA: Bu anket sizin bu biyoloji dersine katılmaktaki istekliliğinizi ölçmektedir. Her bir ifadeye ne kadar katıldığınızı belirtmeniz istenmektedir. Doğru ya da yanlış bir cevap yoktur. İstenen sizin görüşünüzdür. Her bir ifadenin sizin bu derse katılmaktaki istekliliğinizi ne kadar yansıttığını düşünün. Size en uygun seçeneği işaretleyin. Her soruya bir cevap verdiğinizden emin olun.

Kişisel Bilgiler

1. Adınız - Soyadınız: _____

2. Sınıfınız: _____

3. Cinsiyetiniz: □ Kız □ Erkek

4. Doğum tarihiniz (yıl): _____

5. Dokuzuncu sınıf Biyoloji karne notunuz: _____

	Kesinlikle katılmıyorum	**Katılmıyorum**	**Fikrim yok**	**Katılıyorum**	**Kesinlikle katılıyorum**
1. Kolay ya da zor her türlü biyoloji konusunu anlayabileceğimden eminim.	1	2	3	4	5

	Kesinlikle katılmıyorum	Katılmıyorum	Fikrim yok	Katılıyorum	Kesinlikle katılıyorum
2. Zor biyoloji konularını anlamak konusunda kendime güvenmiyorum.	1	2	3	4	5
3. Biyoloji testlerini iyi yapabileceğimden eminim.	1	2	3	4	5
4. Ne kadar çaba sarf etsem de biyolojiyi öğrenemem.	1	2	3	4	5
5. Biyoloji aktiviteleri çok zor olduğunda ya yalnızca kolay kısımları yaparım ya da yapamayacağımı düşünerek vazgeçerim.	1	2	3	4	5
6. Biyoloji aktivitelerinde yer alan soruların cevabını düşünmek yerine bilemeyeceğime inandığım için başkalarına sormayı tercih ederim.	1	2	3	4	5
7. Biyoloji dersinin içeriğini zor bulduğumda anlayamayacağımı düşündüğüm için öğrenmeye çalışmamın faydasız olacağına inanırım.	1	2	3	4	5
8. Yeni biyoloji kavramlarını öğrenirken onları anlamlı bir şekilde öğrenmeye gayret ederim.	1	2	3	4	5
9. Yeni biyoloji kavramlarını öğrenirken onları daha önceki deneyimlerimle ilişkilendiririm.	1	2	3	4	5
10. Bir biyoloji kavramını anlamadığımda bana yardımı olacak ilgili kaynaklar bulurum.	1	2	3	4	5
11. Bir biyoloji kavramını anlamadığımda daha iyi anlamak için konuyu öğretmenimle veya diğer öğrencilerle tartışırım.	1	2	3	4	5
12. Öğrenme süreci içinde öğrendiğim kavramlar arasında ilişki kurmaya çalışırım.	1	2	3	4	5
13. Bir hata yaptığımda nedenini bulmaya çalışırım.	1	2	3	4	5
14. Yeni öğrendiğim biyoloji kavramları daha önce öğrendiklerimle çelişirse nedenini bulmaya çalışırım.	1	2	3	4	5
15. Biyoloji öğrenmenin önemli olduğunu düşünüyorum çünkü bu derste öğrendiklerimi günlük hayatta kullanabilirim.	1	2	3	4	5
16. Biyoloji öğrenmenin önemli olduğunu düşünüyorum çünkü bu dersin içeriği beni düşünmeye sevk ediyor.	1	2	3	4	5
17. Biyoloji öğrenmenin önemli olduğunu düşünüyorum çünkü bilimsel düşünmeyi öğrenmemi sağlıyor.	1	2	3	4	5
18. Biyoloji öğreniminin sorgulayıcı aktivitelere katılımımı sağlayacağı için önemli olduğunu düşünüyorum.	1	2	3	4	5
19. Biyoloji dersinde öğrendiklerimin kendi merakımı giderme şansı verdiği için önemli olduğunu düşünüyorum.	1	2	3	4	5

	Kesinlikle katılmıyorum	Katılmıyorum	Fikrim yok	Katılıyorum	Kesinlikle katılıyorum
20. Biyoloji derslerine iyi notlar alabilmek için katılırım.	1	2	3	4	5
21. Biyoloji derslerine diğer öğrencilerden daha iyi bir performans gösterebilmek için katılırım.	1	2	3	4	5
22. Biyoloji derslerine katılırım böylece diğer öğrenciler zeki olduğumu düşünürler.	1	2	3	4	5
23. Biyoloji derslerine katılırım böylece öğretmen bana ilgi gösterir.	1	2	3	4	5
24. Biyoloji dersi sırasında kendimi en çok bir testte iyi bir not aldığım zaman mutlu hissederim.	1	2	3	4	5
25. Biyoloji dersinde kendimi en çok bir biyoloji konusu hakkında bilgimden emin olduğum zamanlar mutlu hissederim.	1	2	3	4	5
26. Biyoloji dersi sırasında kendimi en çok zor bir soruyu çözebildiğim zaman mutlu hissederim.	1	2	3	4	5
27. Biyoloji dersi sırasında kendimi en çok öğretmenim fikirlerimi kabul ettiği zaman mutlu hissederim.	1	2	3	4	5
28. Biyoloji dersi sırasında kendimi en çok diğer öğrenciler fikirlerimi kabul ettiği zaman mutlu hissederim.	1	2	3	4	5
29. Biyoloji dersine katılmaya istekliyim çünkü öğretmenim çok çeşitli öğretim yöntemleri kullanıyor.	1	2	3	4	5
30. Biyoloji derslerine katılmaya istekliyim çünkü öğretmenim bana çok fazla baskı yapmıyor.	1	2	3	4	5
31. Biyoloji derslerine katılmaya istekliyim çünkü öğretmenim benimle ilgileniyor ve bana önem veriyor.	1	2	3	4	5
32. Biyoloji derslerine katılmaya istekliyim çünkü bu derste öğrenciler sınıf içi tartışmalara katılıyor.	1	2	3	4	5

APPENDIX C

BİLİMSEL İŞLEM BECERİ TESTİ

AÇIKLAMA: Bu test, özellikle Fen ve Matematik derslerinizde ve ilerde üniversite sınavlarında karşınıza çıkabilecek karmaşık gibi görünen problemleri analiz edebilme kabiliyetinizi ortaya çıkarabilmesi açısından çok faydalıdır. Bu test içinde, problemdeki değişkenleri tanımlayabilme, hipotez kurma ve tanımlama, işlemsel açıklamalar getirebilme, problemin çözümü için gerekli incelemelerin tasarlanması, grafik çizme ve verileri yorumlayabilme kabiliyetlerini ölçebilen sorular bulunmaktadır. **Her soruyu okuduktan sonra kendinizce uygun seçeneği işaretleyiniz.**

1. Bir basketbol antrenoru, oyuncuların güçsüz olmasından dolayı maçları kaybettiklerini düşünmektedir. Güçlerini etkileyen faktörleri araştırmaya karar verir. Antrenor, oyuncuların gücünü etkileyip etkilemediğini ölçmek için aşağıdaki değişkenlerden hangisini incelemelidir?

a. Her oyuncunun almış olduğu günlük vitamin miktarını.

b. Günlük ağırlık kaldırma çalışmalarının miktarını.

c. Günlük antrenman süresini.

d. Yukarıdakilerin hepsini.

2. Arabaların verimliliğini inceleyen bir araştırma yapılmaktadır. Sınanan hipotez, benzine katılan bir katkı maddesinin arabaların verimliliğini artırdığı yolundadır. Aynı tip beş arabaya aynı miktarda benzin fakat farklı miktarlarda katkı maddesi konur. Arabalar benzinleri bitinceye kadar aynı yol üzerinde giderler. Daha sonra her arabanın aldığı mesafe kaydedilir. Bu çalışmada arabaların verimliliği nasıl ölçülür?

a. Arabaların benzinleri bitinceye kadar geçen süre ile.

b. Her arabanın gittiği mesafe ile.

c. Kullanılan benzin miktarı ile.

d. Kullanılan katkı maddesinin miktarı ile.

3. Bir araba üreticisi daha ekonomik arabalar yapmak istemektedir. Araştırmacılar arabanın litre başına alabileceği mesafeyi etkileyebilecek değişkenleri araştırmaktadırlar. Aşağıdaki değişkenlerden hangisi arabanın litre başına alabileceği mesafeyi etkileyebilir?

a. Arabanın ağırlığı.

b. Motorun hacmi.

c. Arabanın rengi.

d. a ve b.

4. Ali Bey, evini ısıtmak için komşularından daha çok para ödemesinin sebeplerini merak etmektedir. Isınma giderlerini etkileyen faktörleri araştırmak için bir hipotez kurar. Aşağıdakilerden hangisi bu araştırmada sınanmaya uygun bir hipotez değildir?

a. Evin çevresindeki ağaç sayısı ne kadar az ise ısınma gideri o kadar fazladır.

b. Evde ne kadar çok pencere ve kapı varsa, ısınma gideri de o kadar fazla olur.

c. Büyük evlerin ısınma giderleri fazladır.

d. Isınma giderleri arttıkça ailenin daha ucuza ısınma yolları araması gerekir.

5. Bir polis şefi, arabaların hızının azaltılması ile uğraşmaktadır. Arabaların hızını etkileyebilecek bazı faktörler olduğunu düşünmektedir. Sürücülerin ne kadar hızlı araba kullandıklarını aşağıdaki hipotezlerin hangisiyle sınayabilir?

a. Daha genç sürücülerin daha hızlı araba kullanma olasılığı yüksektir.

b. Kaza yapan arabalar ne kadar büyükse, içindeki insanların yaralanma olasılığı o kadar azdır.

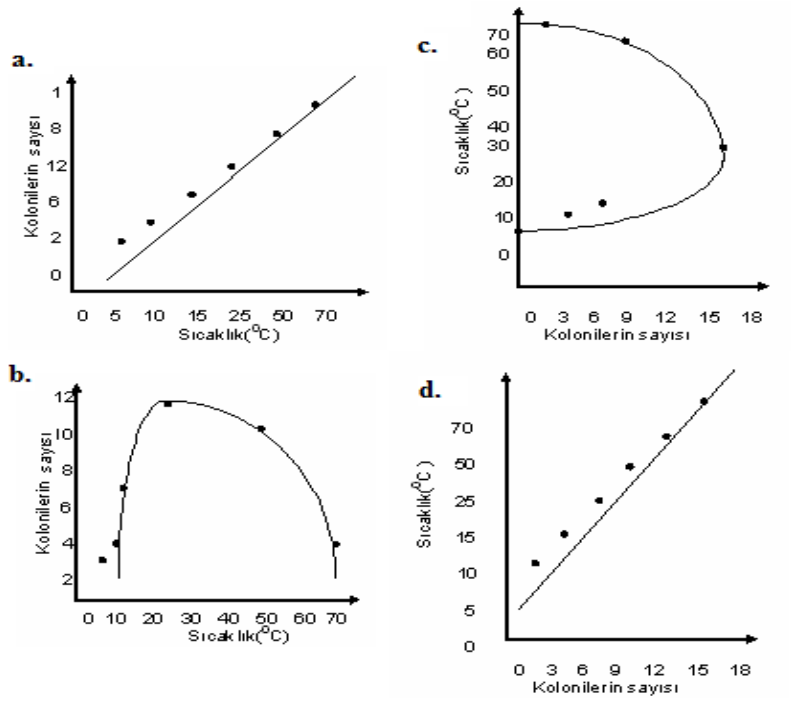
c. Yollarda ne kadar çok polis ekibi olursa, kaza sayısı o kadar az olur.

d. Arabalar eskidikçe kaza yapma olasılıkları artar.

6. Fen sınıfından bir öğrenci sıcaklığın bakterilerin gelişmesi üzerindeki etkilerini araştırmaktadır. Yaptığı deney sonucunda, öğrenci aşağıdaki verileri elde etmiştir:

Deney Oda sıcaklığı (˚C)	Bakteri Kolonilerinin Sayısı
5	0
10	2
15	6
25	12
50	8
70	1

Aşağıdaki grafiklerden hangisi bu verileri doğru olarak göstermekterdir?



7. Bir fen sınıfında, tekerlek yüzeyi genişliğinin tekerleğin daha kolay yuvarlanması üzerine etkisi araştırılmaktadır. Bir oyuncak arabaya geniş yüzeyli tekerlekler takılır, önce bir rampadan (eğik düzlem) aşağı bırakılır ve daha sonra düz bir zemin üzerinde gitmesi sağlanır. Deney, aynı arabaya daha dar yüzeyli tekerlekler takılarak tekrarlanır.Hangi tip tekerleğin daha kolay uvarlandığı nasıl ölçülür?

a. Her deneyde arabanın gittiği toplam mesafe ölçülür.

b. Rampanın (eğik düzlem) eğim açısı ölçülür.

c. Her iki deneyde kullanılan tekerlek tiplerinin yüzey genişlikleri ölçülür.

d. Her iki deneyin sonunda arabanın ağırlıkları ölçülür.

8. Bir çiftçi daha çok mısır üretebilmenin yollarını aramaktadır. Mısırların miktarını etkileyen faktörleri araştırmayı tasarlar. Bu amaçla aşağıdaki hipotezlerden hangisini sınayabilir?

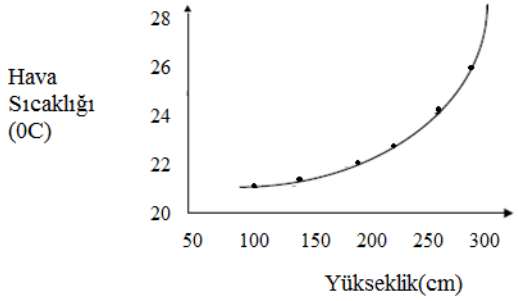
a. Tarlaya ne kadar çok gübre atılırsa, o kadar çok mısır elde edilir.

b. Ne kadar çok mısır elde edilirse, kar o kadar fazla olur.

c. Yağmur ne kadar çok yağarsa , gübrenin etkisi o kadar çok olur.

d. Mısır üretimi arttıkça, üretim maliyeti de artar.

9. Bir odanın tabandan itibaren değisik yüzeylerdeki sıcaklıklarıylala ilgili bir çalışma yapılmış ve elde edilen veriler aşağıdaki grafikte gösterilmiştir. Değişkenler arasındaki ilişki nedir?



a. Yükseklik arttıkça sıcaklık azalır.

b. Yükseklik arttıkça sıcaklık artar.

c. Sıcaklık arttıkça yükseklik azalır.

d. Yükseklik ile sıcaklık artışı arasında bir ilişki yoktur.

10. Ahmet, basketbol topunun içindeki hava arttıkça, topun daha çsıcrayacağını düşünmektedir. Bu hipotezi araştırmak için, birkaç basketbol topu alır ve içlerine farklı miktarda hava pompalar. Ahmet hipotezini nasıl sınamalıdır?

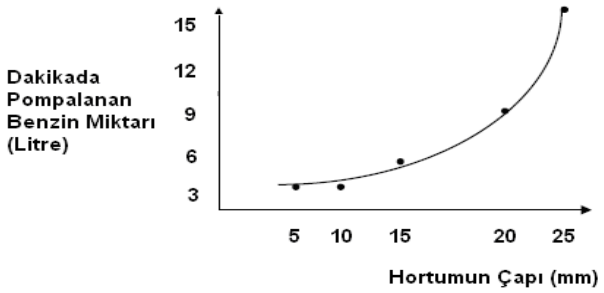
a. Topları aynı yükseklikten fakat değişik hızlarla yere vurur.

b. İçlerinde farlı miktarlarda hava olan topları, aynı yükseklikten yere bırakır.

c. İçlerinde aynı miktarlarda hava olan topları, zeminle farklı açılardan yere vurur.

d. İçlerinde aynı miktarlarda hava olan topları, farklı yüksekliklerden yere bırakır.

11. Bir tankerden benzin almak için farklı genişlikte 5 hortum kullanılmaktadır. Her hortum için aynı pompa kullanılır. Yapılan çalışma sonunda elde edilen bulgular aşağıdaki grafikte gösterilmiştir.



Aşağıdakilerden hangisi değişkenler arasındaki ilişkiyi açıklamaktadır?

a. Hortumun çapı genişledikçe dakikada pompalanan benzin miktarı da artar.

b. Dakikada pompalanan benzin miktarı arttıkça, daha fazla zaman gerekir.

c. Hortumun çapı küçüldükce dakikada pompalanan benzin miktarı da artar.

d. Pompalanan benzin miktarı azaldıkça, hortumun çapı genisler.

Önce aşağıdaki açıklamayı okuyunuz ve daha sonra 12, 13, 14 ve 15 inci soruları açıklama kısmından sonra verilen paragrafı okuyarak cevaplayınız.

Açıklama: Bir araştırmada, bağımlı değişken birtakım faktörlere bağımlı olarak gelişim gösteren değiskendir. Bağımsız değişkenler ise bağımlı değişkene etki eden faktörlerdir. Örneğin, araştırmanın amacına gore kimya başarısı bağımlı bir değişken olarak alınabilir ve ona etki edebilecek faktör veya faktörler de bağımsız değişkenler olurlar.

Ayşe, güneşin karaları ve denizleri aynı derecede ısıtıp ısıtmadığını merak etmektedir. Bir araştırma yapmaya karar verir ve aynı büyüklükte iki kova alır. Bunlardan birini toprakla, diğerini de su ile doldurur ve aynı miktarda güneş ısısı alacak şekilde bir yere koyar. 8.00 - 18.00 saatleri arasında, her saat başı sıcaklıklarını ölçer.

12. Araştırmada aşağıdaki hipotezlerden hangisi sınanmıştır?

a. Toprak ve su ne kadar çok güneş ışığı alırlarsa, o kadar ısınırlar.

b. Toprak ve su güneş altında ne kadar fazla kalırlarsa, o kadar çok ısınırlar.

c. Güneş farklı maddeleri farklı derecelerde ısıtır.

d. Günün farklı saatlerinde güneşin ısısı da farklı olur.

13. Araştırmada aşağıdaki değişkenlerden hangisi kontrol edilmiştir?

a. Kovadaki suyun cinsi.

b. Toprak ve suyun sıcaklığı.

c. Kovalara koyulan maddenin .

d. Her bir kovanın güneş altında kalma süresi.

14. Araştırmada bağımlı değişken hangisidir?

a. Kovadaki suyun cinsi.

b. Toprak ve suyun sıcaklığı.

c. Kovalara koyulan maddenin türü.

d. Her bir kovanın güneş altında kalma süresi.

15. Araştırmada bağımsız değişken hangisidir?

a. Kovadaki suyun cinsi.

b. Toprak ve suyun sıcaklığı.

c. Kovalara koyulan maddenin türü.

d. Her bir kovanın güneş altında kalma süresi.

16. Can, yedi ayrı bahçedeki çimenleri biçmektedir. Çim biçme makinesiyle her hafta bir bahçedeki çimenleri biçer. Çimenlerin boyu bahçelere göre farklı olup bazılarında uzun bazılarında kısadır. Çimenlerin boyları ile ilgili hipotezler kurmaya başlar. Aşağıdakilerden hangisi sınanmaya uygun bir hipotezdir?

a. Hava sıcakken çim biçmek zordur.

b. Bahçeye atılan gübrenin miktarı önemlidir.

c. Daha çok sulanan bahçedeki çimenler daha uzun olur.

d. Bahçe ne kadar engebeliyse çimenleri kesmekte o kadar zor olur.

17, 18, 19 ve 20 inci soruları aşağıda verilen paragrafı okuyarak cevaplayınız.

Murat, suyun sıcaklığının, su içinde çözünebilecek şeker miktarını etkileyip etkilemediğini araştırmak ister. Birbirinin aynı dört bardağın her birine 50 şer mililitre su koyar. Bardaklardan birisine 0 0C de, diğerine de sırayla 50 0C, 75 0C ve 95 0C sıcaklıkta su koyar. Daha sonra her bir bardağa çözünebileceği kadar şeker koyar ve karıştırır.

17. Bu araştırmada sınanan hipotez hangisidir?

a. Şeker ne kadar çok suda karıştırılırsa o kadar çok çözünür.

b. Ne kadar çok şeker çözünürse, su o kadar tatlı olur.

c. Sıcaklık ne kadar yüksek olursa, çözünen şekerin miktarı o kadar fazla olur.

d. Kullanılan suyun miktarı arttıkça sıcaklığı da artar.

18. Bu araştırmada kontrol edilebilen değişken hangisidir?

a. Her bardakta çözünen şeker miktarı.

b. Her bardağa konulan su miktarı.

c. Bardakların sayısı.

d. Suyun sıcaklığı.

19. Araştırmanın bağımlı değişkeni hangisidir?

a. Her bardakta çözünen şeker miktarı.

b. Her bardağa konulan su miktarı.

c. Bardakların sayısı.

d. Suyun sıcaklığı.

20. Araştırmadaki bağımsız değişken hangisidir?

a. Her bardakta çözünen şeker miktarı.

b. Her bardağa konulan su miktarı.

c. Bardakların sayısı.

d. Suyun sıcaklığı.

21. Bir bahçıvan domates üretimini artırmak istemektedir. Değişik birkaç alana domates tohumu eker. Hipotezi, tohumlar ne kadar çok sulanırsa, o kadar çabuk filizleneceğidir. Bu hipotezi nasıl sınar?

a. Farklı miktarlarda sulanan tohumların kaç günde filizleneceğine bakar.

b. Her sulamadan bir gün sonra domates bitkisinin boyunu ölçer.

c. Farklı alanlardaki bitkilere verilen su miktarını ölçer.

d. Her alana ektiği tohum sayısına bakar.

22. Bir bahçıvan tarlasındaki kabaklarda yaprak bitleri gorur. Bu bitleri yok etmek gereklidir. Kardeşi "Kling" adlı tozun en iyi böcek ilacı olduğunu söyler. Tarım uzmanları ise "Acar" adlı spreyin daha etkili olduğunu söylemektedir. Bahçıvan altı tane kabak bitkisi seçer. Üç tanesini tozla, üç tanesini de spreyle ilaçlar. Bir hafta sonra her bitkinin üzerinde kalan canlı bitleri sayar. Bu çalışmada böcek ilaclarının etkinliği nasıl ölçülür?

a. Kullanılan toz yada spreyin miktarı ölçülür.

b. Toz yada spreyle ilaçlandıktan sonra bitkilerin durumları tespit edilir.

c. Her fidede oluşan kabağın ağırlığı ölçülür.

d. Bitkilerin üzerinde kalan bitler sayılır.

23. Ebru, bir alevin belli bir zaman süresi içinde meydana getireceği ısı enerjisi miktarını ölçmek ister. Bir kabın içine bir litre soğuk su koyar ve 10 dakika süreyle ısıtır. Ebru, alevin meydana getirdiği ısı enerjisini nasıl ölçer?

a. 10 dakika sonra suyun sıcaklığında meydana gelen değişmeyi kaydeder.

b. 10 dakika sonra suyun hacminde meydana gelen değişmeyi ölçer.

c. 10 dakika sonra alevin sıcaklığını ölçer.

d. Bir litre suyun kaynaması için geçen zamanı ölçer.

24. Ahmet, buz parçacıklarının erime süresini etkileyen faktörleri merak etmektedir. Buz parçalarının büyüklüğü, odanın sıcaklığı ve buz parçalarının şekli gibi faktörlerin erime süresini etkileyebileceğini düşünür. Daha sonra şu hipotezi sınamaya karar verir:

Buz parçalarının şekli erime süresini etkiler. Ahmet bu hipotezi sınamak için aşağıdaki deney tasarımlarının hangisini uygulamalıdır?

a. Her biri farklı şekil ve ağırlıkta beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

b. Her biri aynı şekilde fakat farklı ağırlıkta beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

c. Her biri aynı ağırlıkta fakat farklı şekillerde beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

d. Her biri aynı ağırlıkta fakat farklı şekillerde beş buz parçası alınır. Bunlar farklı

sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

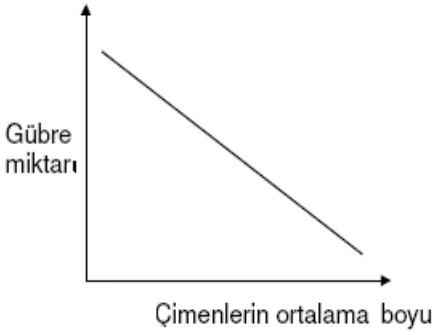
25. Bir araştırmacı yeni bir gübreyi denemektedir. Çalışmalarını aynı büyüklükte beş tarlada yapar. Her tarlaya yeni gübresinden değişik miktarlarda karıştırır. Bir ay sonra, her tarlada yetişen çimenin ortalama boyunu ölçer. Ölçüm sonuçları aşağıdaki tabloda verilmiştir.

Gübre miktarı (kg)	Çimenlerin ortalama boyu (cm)
10	7
30	10
50	12
80	14
100	12

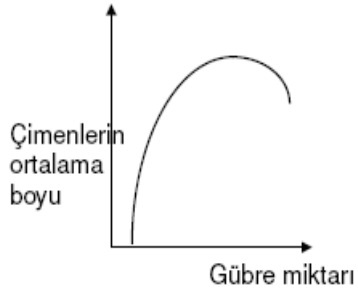
Tablodaki verilerin grafiği aşağıdakilerden hangisidir?

a.

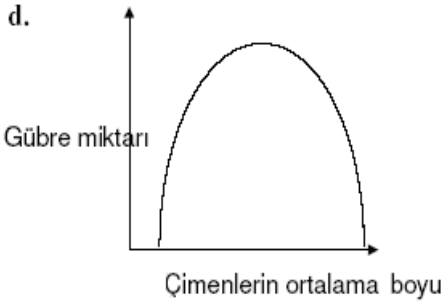
b.



c.



d.



26. Bir biyolog şu hipotezi test etmek ister: Farelere ne kadar çok vitamin verilirse o kadar hızlı büyürler. Biyolog farelerin büyüme hızını nasıl ölçebilir?

a. Farelerin hızını ölçer.

b. Farelerin, günlük uyumadan durabildikleri süreyi ölçer.

c. Her gün fareleri tartar.

d. Her gün farelerin yiyeceği vitaminleri tartar.

27. Öğrenciler, şekerin suda çözünme süresini etkileyebilecek değişkenleri düşünmektedirler. Suyun sıcaklığını, şekerin ve suyun miktarlarını değişken olarak

saptarlar. Öğrenciler, şekerin suda çözünme süresini aşağıdaki hipotezlerden hangisiyle sınayabilir?

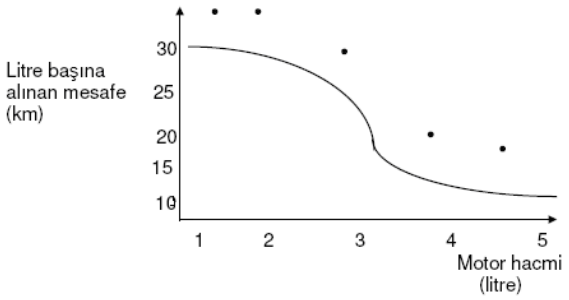
a. Daha fazla şekeri çözmek için daha fazla su gereklidir.

b. Su soğudukca, şekeri çözebilmek için daha fazla karıştırmak gerekir.

c. Su ne kadar sıcaksa, o kadar çok şeker çözünecektir.

d. Su ısındıkca şeker daha uzun sürede çözünür.

28. Bir araştırma grubu, değisik hacimli motorları olan arabaların randımanlarını ölçer. Elde edilen sonuçların grafiği aşağıdaki gibidir:



Aşağıdakilerden hangisi değişkenler arasındaki ilişkiyi gösterir?

a. Motor ne kadar büyükse, bir litre benzinle gidilen mesafe de o kadar uzun olur.

b. Bir litre benzinle gidilen mesafe ne kadar az olursa, arabanın motoru o kadar küçük demektir.

c. Motor küçüldükce, arabanın bir litre benzinle gidilen mesafe artar.

d. Bir litre benzinle gidilen mesafe ne kadar uzun olursa, arabanın motoru o kadar büyük demektir.

29, 30, 31 ve 32 inci soruları aşağıda verilen paragrafı okuyarak cevaplayınız.

Toprağa karıştırılan yaprakların domates üretimine etkisi araştırılmaktadır. Araştırmada dört büyük saksıya aynı miktarda ve tipte toprak konulmuştur. Fakat birinci saksıdaki toprağa 15 kg., ikinciye 10 kg., üçüncüye ise 5 kg. çürümüş yaprak karıştırılmıştır.

Dördüncü saksıdaki toprağa ise hiç çürümüş yaprak karıştırılmamıştır.Daha sonra bu saksılara domates ekilmiştir. Butun saksılar güneşe konmuş ve aynı miktarda sulanmıştır. Her saksıdan elde edilen domates tartılmış ve kaydedilmiştir.

29. Bu araştırmada sınanan hipotez hangisidir?

a. Bitkiler güneşten ne kadar çok ışık alırlarsa, o kadar fazla domates verirler.

b. Saksılar ne kadar büyük olursa, karıştırılan yaprak miktarı o kadar fazla olur.

c. Saksılar ne kadar çok sulanırsa, içlerindeki yapraklar o kadar çabuk çürür.

d. Toprağa ne kadar çok çürük yaprak karıştırılırsa, o kadar fazla domates elde edilir.

30. Bu araştırmada kontrol edilen değisken hangisidir?

a. Her saksıdan elde edilen domates miktarı

b. Saksılara karıştırılan yaprak miktarı.

c. Saksılardaki toprak miktarı.

d. Çürümüş yaprak karıştırılan saksı sayısı.

31. Araştırmadaki bağımlı değisken hangisidir?

a. Her saksıdan elde edilen domates miktarı

b. Saksılara karıştırılan yaprak miktarı.

c. Saksılardaki toprak miktarı.

d. Çürümüş yaprak karıştırılan saksı sayısı.

32. Araştırmadaki bağımsız değisken hangisidir?

a. Her saksıdan elde edilen domates miktarı

b. Saksılara karıştırılan yaprak miktarı.

c. Saksılardaki toprak miktarı.

d. Çürümüş yaprak karıştırılan saksı sayısı.

33. Bir öğrenci mıknatısların kaldırma yeteneklerini araştırmaktadır. Çesitli boylarda ve şekillerde birkaç mıknatıs alır ve her mıknatısın çektiği demir tozlarını tartar. Bu çalışmada mıknatısın kaldırma yeteneği nasıl tanımlanır?

a. Kullanılan mıknatısın büyüklüğü ile.

b. Demir tozlarını ceken mıknatısın ağırlığı ile.

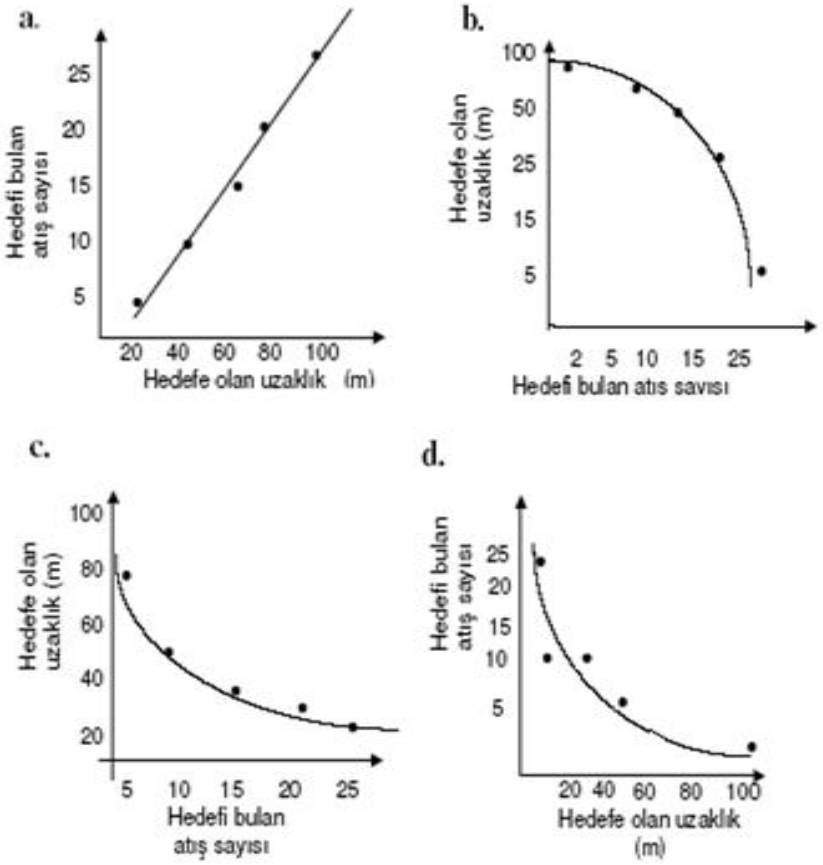
c. Kullanılan mıknatısın şekli ile.

d. Çekilen demir tozlarının ağırlığı ile.

34. Bir hedefe çesitli mesafelerden 25 er atış yapılır. Her mesafeden yapılan 25 atıştan hedefe isabet edenler aşağıdaki tabloda gösterilmiştir.

Mesafe(m)	Hedefe vuran atış sayısı
5	25
15	10
25	10
50	5
100	2

Aşağıdaki grafiklerden hangisi verilen bu verileri en iyi şekilde yansıtır?



35. Sibel, akvaryumdaki balıkların bazen çok hareketli bazen ise durgun olduklarını gözler. Balıkların hareketliliğini etkileyen faktörleri merak eder. Balıkların hareketliliğini etkileyen faktörleri hangi hipotezle sınayabilir?

a. Balıklara ne kadar çok yem verilirse, o kadar çok yeme ihtiaçları vardır.

b. Balıklar ne kadar hareketli olursa o kadar çok yeme ihtiyaçları vardır.

c. Su da ne kadar çok oksijen varsa, balıklar o kadar iri olur.

d. Akvaryum ne kadar çok ışık alırsa, balıklar o kadar hareketli olur.

36. Murat Bey'in evinde birçok elektrikli alet vardır. Fazla gelen elektrik faturaları dikkatini çeker. Kullanılan elektrik miktarını etkileyen faktörleri araştırmaya karar verir. Aşağıdaki değişkenlerden hangisi kullanılan elektrik enerjisi miktarını etkileyebilir?

a. TV nin açık kaldığı süre.

b. Elektrik sayacının yeri.

c. Çamasır makinasını kullanma sıklığı.

d. a ve c.

APPENDIX D

HEDEF BELİRLEME STRATEJİLERİ ANKETİ

Bu anket sizin başarı amaçlı hedef belirleme yeteneğinizi ölçmek amacı ile hazırlanmıştır. Verilen her cümleyi dikkatle okuduktan sonra, her cümlenin karşısında **1 (Hiç Katılmıyorum)** den **7 (Tamamen Katılıyorum)** ye kadar belirlenmiş seçeneklerden size en uygun olanını yuvarlak içine alınız.

Kişisel Bilgiler

1. Adınız - Soyadınız: _____

2. Sınıfınız: _____

3. Cinsiyetiniz: □ Kız □ Erkek

4. Doğum tarihiniz (yıl): _____

5. Dokuzuncu sınıf Biyoloji karne notunuz: _____

1. Diğer öğrencilerden daha başarılı olmak benim için önemlidir.	1	2	3	4	5	6	7
2. Diğer öğrenciler ile hep iyi yönde karşılaştırılmak isterim.	1	2	3	4	5	6	7
3. Sınıftaki hedefim diğer öğrencilerden daha iyi not almaktır.	1	2	3	4	5	6	7
4. Dersden edinebiliceğim herşeyi tüm kapasitemi kullanmadığım için eksik olarak öğrenmekten endişelenirim.	1	2	3	4	5	6	7
5. Bazen ders içeriğini çok iyi anlamak istediğim halde, istediğim seviyede anlayamamaktan korkarım.	1	2	3	4	5	6	7
6. Genellikle dersteki herşeyi öğrenemeyebiliceğimden korkarım.	1	2	3	4	5	6	7
7. Bir dersden mümkün olan en fazla seviyede bilgi öğrenmek isterim.	1	2	3	4	5	6	7
8. Benim için ders içeriğini elimden gelen en iyi şekilde anlamak önemlidir.	1	2	3	4	5	6	7
9. Ders içerisinde bana sunulan her şeyde sonuna kadar ustalaşmak isterim.	1	2	3	4	5	6	7
10. Ders içerisindeki çabam başarısız olmamaktır.	1	2	3	4	5	6	7
11. Dersdeki hedefim düşük bir performans sergilememi önlemektir.	1	2	3	4	5	6	7
12. Başarısız olmaktan duyduğum korku beni ders içerisinde motive eden tek kaynaktır.	1	2	3	4	5	6	7

APPENDIX E

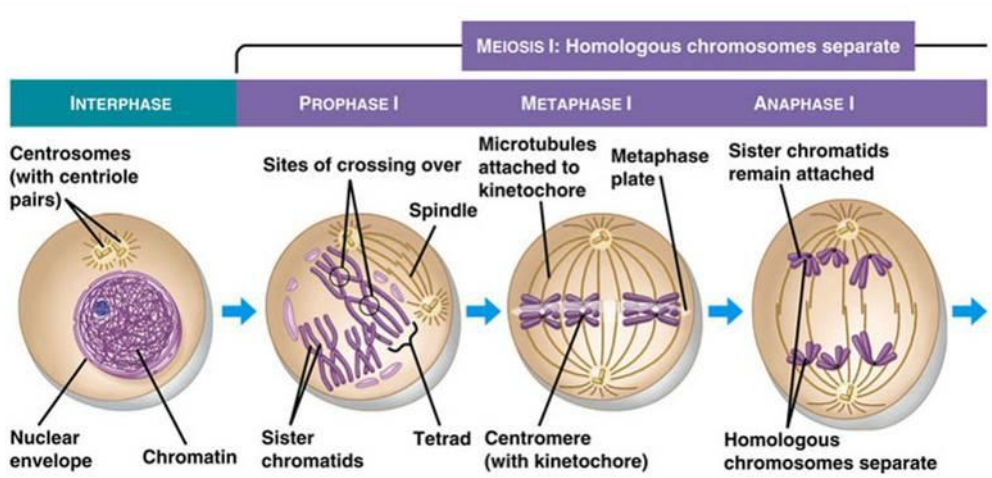
CHROMOSOME MOVEMENTS DURING MEIOSIS

Introduction:

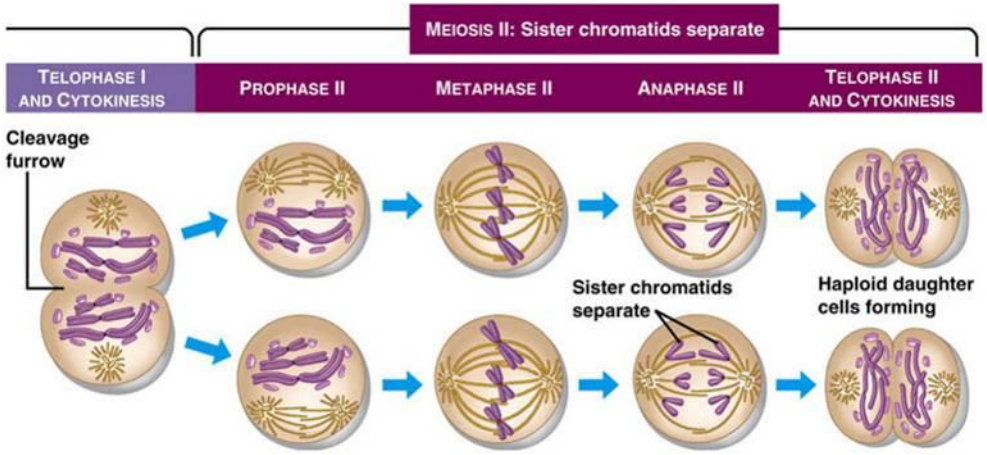
Meiosis is an important type of cell division. By meiosis number of chromosomes in the cell reduced by one- half of the number of the chromosomes in the original cell. And at the end, four daughter cells produced. These features provide the continuity of the species.

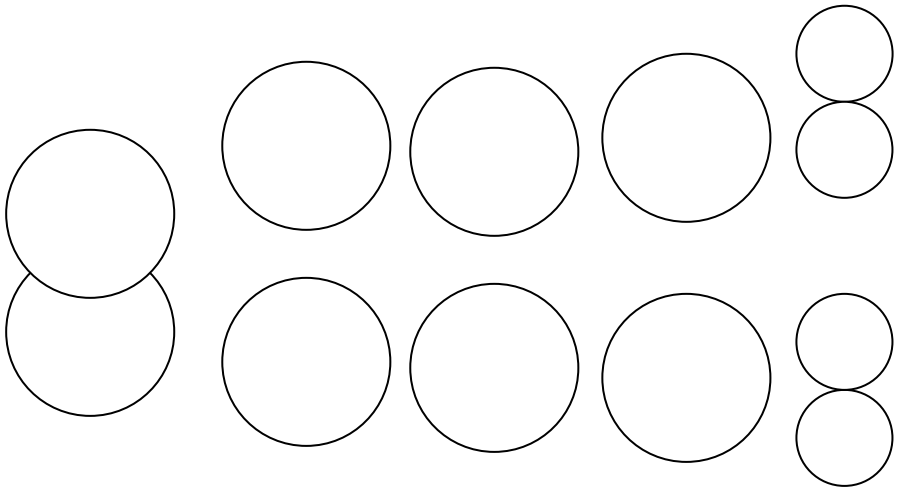
What is expected?

Draw stages of the meiosis on the appropriate part of the worksheet. Then answer the following parts.


MEIOSIS I: Homologous chromosomes separate
INTERPHASE
PROPHASE I
METAPHASE I
ANAPHASE I
Centrosomes (with centriole pairs)
Nuclear envelope
Chromatin
Sites of crossing over
Spindle
Sister chromatids
Tetrad
Microtubules attached to kinetochore
Metaphase plate
Centromere (with kinetochore)
Sister chromatids remain attached
Homologous chromosomes separate

Cell


MEIOSIS II: Sister chromatids separate
TELOPHASE I AND CYTOKINESIS
PROPHASE II
METAPHASE II
ANAPHASE II
TELOPHASE II AND CYTOKINESIS
Cleavage furrow
Sister chromatids separate
Haploid daughter cells forming



Complete the table by using your drawings.

Stage		**Number of cells**	**Chromatids per Cells**	**Double chromosomes (yes/ no)**
Prophase1				
Telophase1	**Separation of** _____ _____			
Telophase2	**Separation of** _____ _____			

- **Explain the terms below either by drawing or by sentences and if they are separated state the stage.**

  Tetrad

  Synapses

  Crossing over

  Centromere

  Homologous chromosome

  Centriole

  Chromatin

  Sister chromatids

APPENDIX F

OOGENESIS

1. In below Mary tries to explain the process of Oogenesis, but she mixed the sequence of the events. Put the sentences in right order by using your handouts.

a) One of the primary oocyte inside the follicle now divides by meiosis. _____

b) Each oogonium grows into a primary oocyte._____

c) Primordial germ cells in the germinal epithelium divide by mitosis.____

d) The second meiotic division occurs which produces the ovum and another small polar body._____

e) The first meiotic division produces a secondary oocyte and attached to it a small cell called a polar body._____

f) Oogonia is formed._____

APPENDIX G

SPERMATOGENESIS

1. In below Bob tries to explain the process of spermatogenesis, but he mixed the sequence of the events. Put the sentences in right order by using your handouts.

a) Divisions of the primordial germ cells make up the germinal epithelium.____

b) Sperm differentiated from the spermatids.____

c) Then they begin to divide by meiosis. The first meiotic division produces secondary spermatocytes.____

d) It increases in size and mass to become primary spermatocytes.____

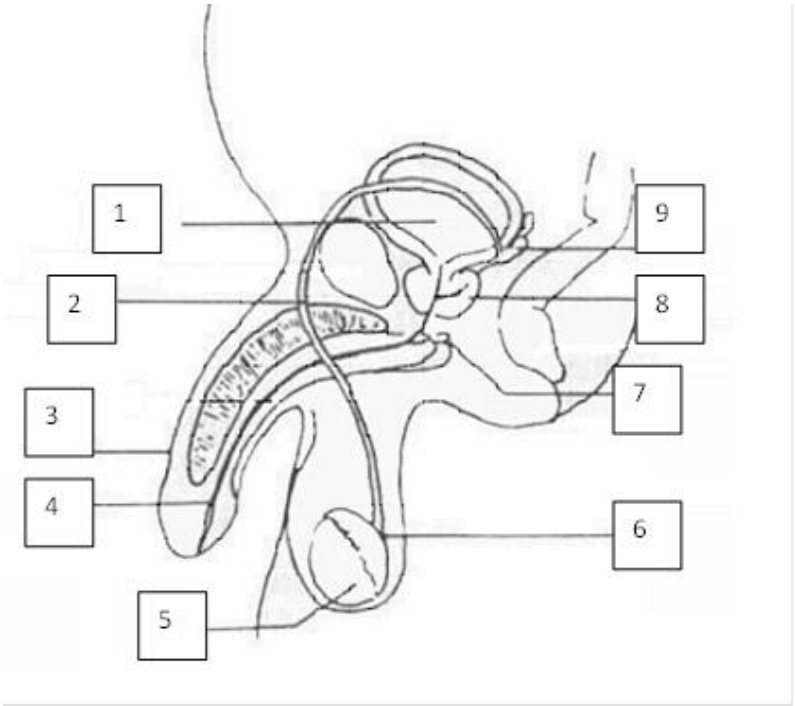
e) The divisions are mitotic and produce many genetically identical cells called spermatogonia.____

f) Secondary meiotic division gives rise to spermatids._____

2. In which type of a cell and after which process we can see flagellum? What is the function of flagellum?

APPENDIX H

MALE REPRODUCTIVE SYSTEM



1. Label the diagram with using the following words:

Vas deferens	Urinary bladder	Seminal vesicle
Prostate gland	Cowper's gland	Testes
Scrotum		
Epididymis	Urethra	Penis

2. Write their definition under the label.

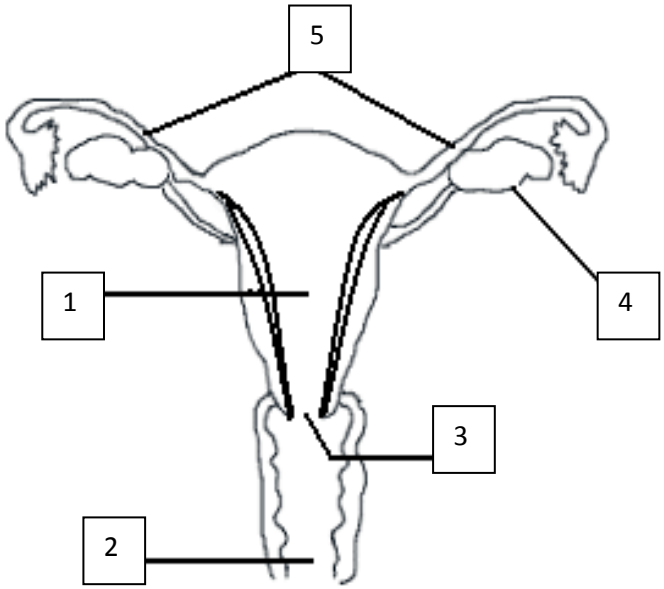
3. Shade on blue where sperms are made.

4. Shade in red where fluid is added to sperms.

5. Shade in yellow the tubes that sperms pass through to get to the outside.

APPENDIX I

FEMALE REPRODUCTIVE SYSTEM



1. Label the diagram with using the following words:

Ovary	Oviduct	Vagina	Cervix	Uterus

2. Write their definition under the label.

3. Shade in red where fertilization takes place.

4. Shade in blue where eggs are made.

5. Shade in yellow where baby develops.

6. List the parts that the egg would pass through on its way out of the body.

APPENDIX J

FERTILIZATION

___a) Egg is passing down through the place at this time. It secretes chemicals to attract sperm.

___b) Sperm pass through uterus.

___c) Sperm pass through cervix.

___d) Sperm nucleus fuses with the egg nucleus.

___e) One of the sperm breaks through the membranes surrounding through the egg.

___f) Sperm come to the oviduct.

___g) After sexual intercourse hundreds of sperms are ejaculated in the vagina.

___h) The membranes around the egg change, stopping other sperm from entering the egg cell.

___i) Diploid cell produced.

___j) Sperm cell nucleus enters the cytoplasm of the egg cell.

APPENDIX K

HORMONAL CONTROL IN MALES

Read the paragraph below and draw a diagram. The diagram must show the secretion place of the hormones, where it effects and how it effects. You may use circle, triangular or rectangular to show the secretion place, and arrows to show the relation between the secretion place and the stimulation place of the hormones.

The hypothalamus secretes a releasing hormone that regulates release of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) by the anterior pituitary gland. FSH and LH will stimulate the testes. FSH increases sperm production by the testes, while LH promotes the secretion of androgens. Androgens stimulate sperm production. In addition, androgens carried in the blood help maintain homeostasis by a negative-feedback mechanism, inhibiting secretion of both releasing hormone and LH. Under control of this chemical regulating system, the testes produce hundreds of millions of sperm every day, from puberty well into old age.

APPENDIX L

CHROMOSOME MOVEMENTS DURING MEIOSIS

Introduction:

Meiosis is an important type of cell division. By meiosis number of chromosomes in the cell reduced by one- half of the number of the chromosomes in the original cell. And at the end, four daughter cells produced. These features provide the continuity of the species.

Aim of the experiment:

To understand meiosis by using a model.

Scenario

Imagine a cell with four chromosomes. Your task is to move the chromosomes through meiosis. As you do so, think about the orderly movements of the chromosomes in meiosis.

Materials:

- Pipe cleaner

Procedure:

1) Put each pipe cleaner on the piece of paper that is representing the cell randomly for symbolizing chromosomes in the very beginning of meiosis.

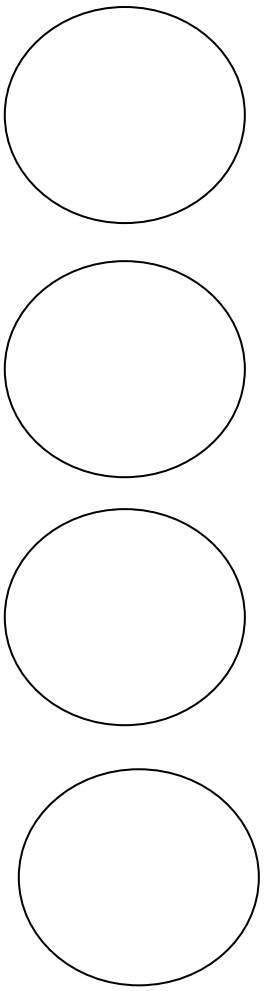
2) Draw this on the appropriate circle on the other page.

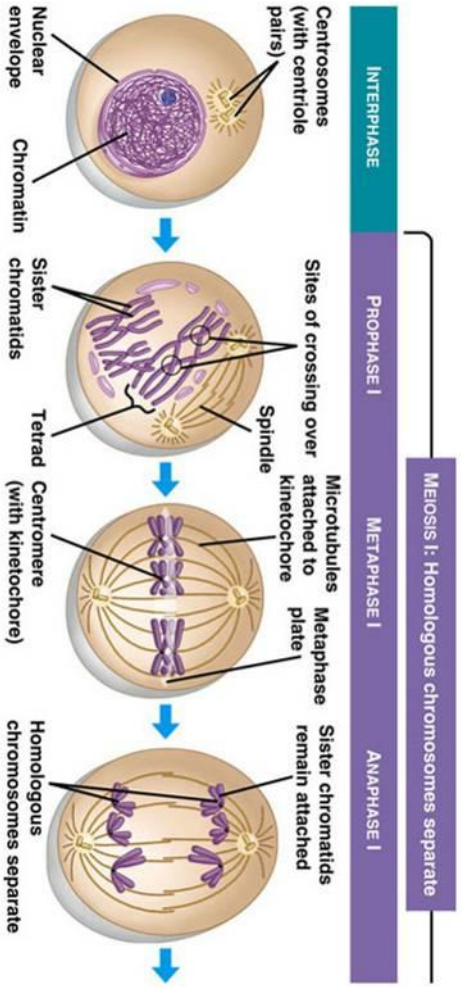
3) During interphase1 the chromosomes will become double chromosome so put other pipe cleaners according to the number of chromosome on your cell on the paper. Draw this on the appropriate circle on the other page.

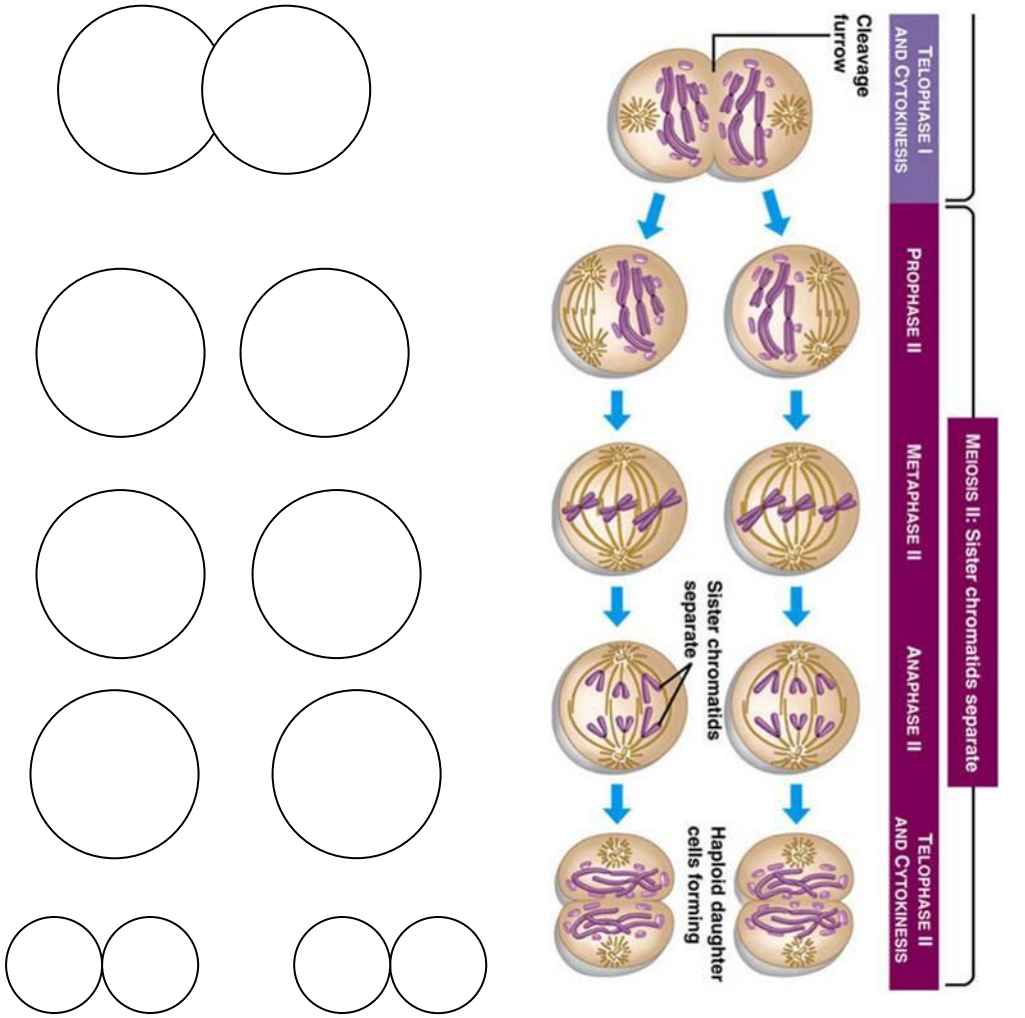
4) Now demonstrate the meiosis by your chromosomes and in each step draw a picture of your demonstration on the appropriate circle on the other page.

5) Complete the table on the page 3, by using your drawings.

Cell






Meiosis II: Sister chromatids separate
Telophase I and cytokinesis
Prophase II
Metaphase II
Anaphase II
Telophase II and cytokinesis
Cleavage furrow
Sister chromatids separate
Haploid daughter cells forming

Complete the table by using your drawings.

Stage		**Number of cells**	**Chromatids per Cells**	**Double chromosomes (yes/ no)**
Prophase1				
Telophase1	**Separation of** _____ _____			
Telophase2	**Separation of** _____ _____			

-

- **Explain the terms below either by drawing or by sentences and if they are separated state the stage.**

  Tetrad

  Synapses

  Crossing over

  Centromere

  Homologous chromosome

  Centriole

  Chromatin

  Sister chromatids

APPENDIX M

EVALUATING SECONDHAND INFORMATION

How do you know whether or not to believe something you read? Consider the following situation. A magazine is lying open on a library table. The title of an article attracts your attention. You read:

Leanness and Infertility

The loss of fat because of exercise or dieting can result in infertility in women. This infertility can be reserved when fat is gained. Fat tissue may help determine whether human females can reproduce.

In the article, the author describes scientific research conducted over 15 years. Scientists found that a certain ratio of fat body tissue to lean body tissue is required for menstruating. When fat tissue decreased below that level, menstruation stopped. When fat tissue was gained, menstruation resumed.

Although you do not recognize the name of the magazine, you see on the contents page that it has been published over 100 years. The magazine contains articles about sciences topics for general readers. Notes on the author of the article state that she reported medical news for more than 20 years.

1. How reliable would you judge the information in the article to be? Explain and describe your thought process.

2. What additional information might help you to evaluate the reliability of the information in the article?

3. Suppose the article appeared in a tabloid that carried sensational news. How might this affect your judgment?

APPENDIX N

LESSON PLAN FOR SPERMATOGENESIS

In the very beginning of the lesson students came together with their groups and sit in the places that were arranged beforehand. Later on for 13 minutes checking worksheets about sequencing the stages of oogenesis was done as a whole class activity. At first each group told which item they have placed as the first event, and then same process was repeated for each event for the rest of the sequences in numerical order. After identifying the sequence of a single event even if all groups had the correct placement, one student from each group explain their reasoning. If answers vary between groups in terms of either reasoning or the placement class would made a discussion. Teacher prompted the discussion with open ended questions in addition to being a facilitator, supportive, reassuring and attentive. During the discussions teacher guided students to listen each other, explain why they have made the placement in that way and understand others point of view. If the discussion ended with wrong placement as a whole class teacher stated open ended questions like “Are you sure?” rather than directly stating that it is a wrong answer and showed the animation about oogenesis one more time and made class give the correct answer by manipulating with questioning. Instructor also kept in mind to be a role model for enthusiasm and thinking in addition to dealing with errors and challenges.

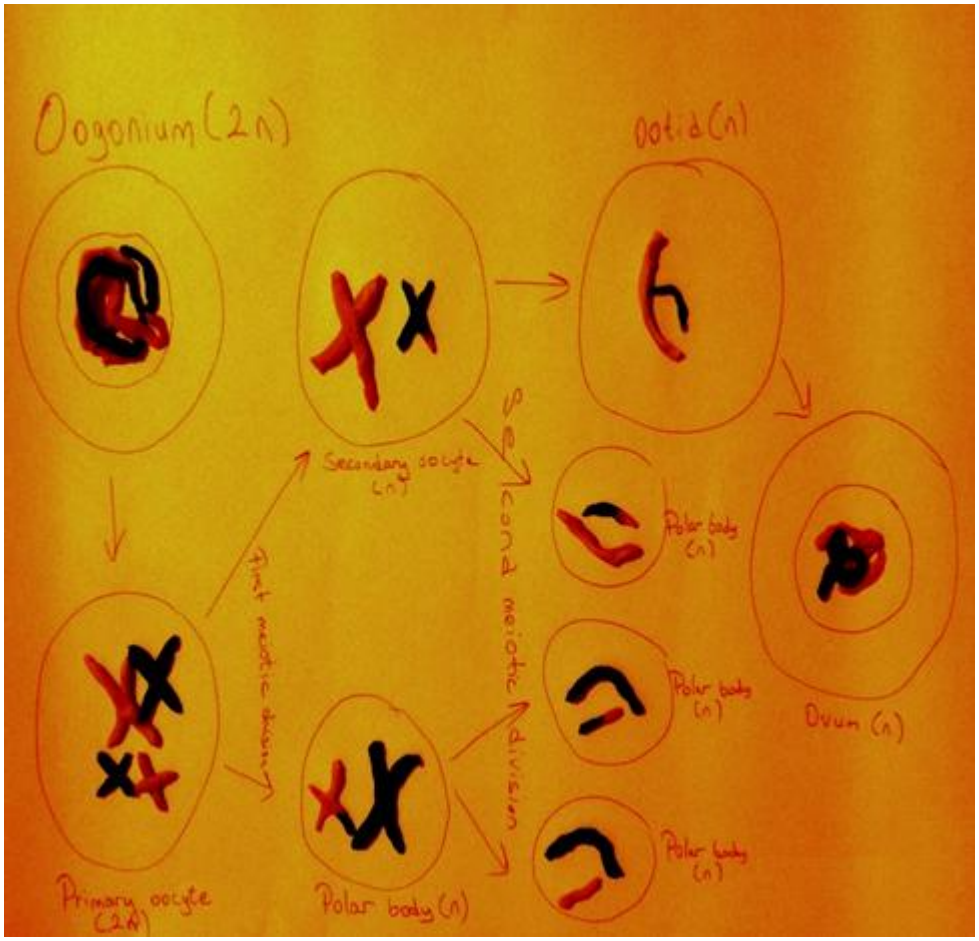
At the end of thirteen minutes animation about spermatogenesis was shown approximately about two minutes. For the next twenty minutes students were expected to make the physical model of the process with their play dough. Again

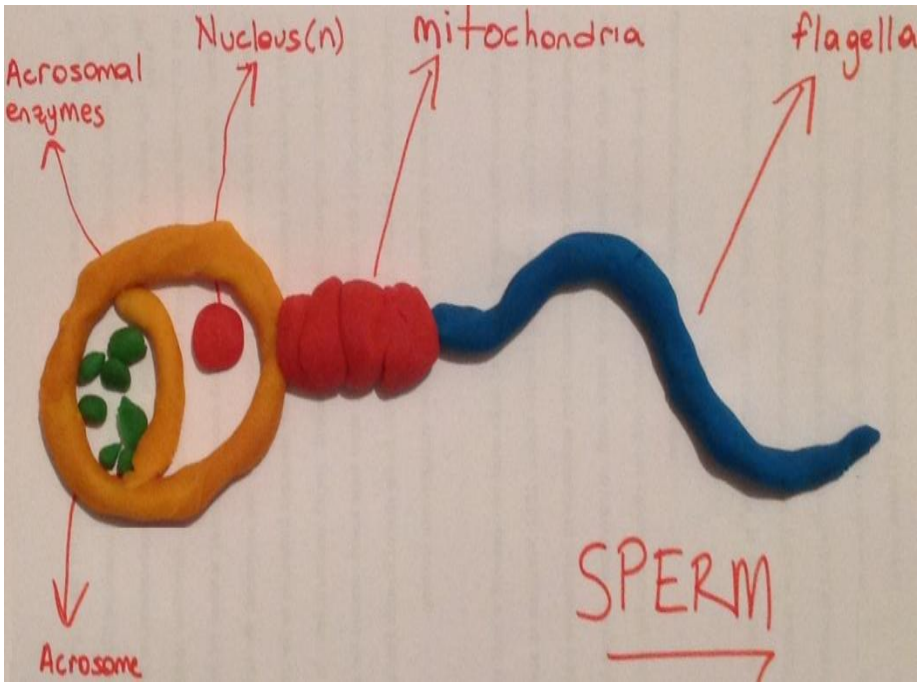
reduction of the chromosomes, name and number of chromosome of the cells were expected to be shown and labels that were expected were written on the board. During these processes teacher walked around and detected misconceptions. Once misconceptions was realized group of the students manipulated by questioning. Instructor used positive praises as well while interacting with the students and focused on their progress. Another important role of the instructor is to enhance collaborative work of students in addition to making students actively participate and assist to each other. If students in any group have difficulties about the process, without any permission from the teacher they had a chance to replay the animation or even find another one on the internet.

At the last 10 minutes construction of physical models completed and each group changed their places and checked the model of each other. Teacher prompted students in a way to discourage competition but to encourage observation of others model, schemes, and ways to express the process in addition to being sure that each group has seen the work of other. Therefore main aim was to see and become aware of others schemes rather than the comparison.

APPENDIX O

SOME OF THE CONSTRUCTED PHYSICAL MODELS




Acrosomal enzymes
Nucleus(n)
mitochondria
flagella
SPERM
Acrosome

CURRICULUM VITAE

PERSONAL INFORMATION:

Surname, Name: Esendemir, Gonca

Nationality: Turkish

Date and Place of Birth: 21th November 1984, Ankara (Turkey)

Sex: Female

Marital Status: Single

Phone: +90 312 586 90 00

e-mail: gesendemir@gmail.com

Present Occupation: Biology and Environmental System and Societies Teacher,

SL IB Biology (Grade 11/12)

SL IB Environmental System and Societies (Grade 11/12)

National Curriculum Biology (Grade 9/10/11/12)

EDUCATION:

Degree	Institution	Year of Graduation
BA	Hacettepe University, Science Faculty, Biology Department	2005
MA	Bilkent University, Graduate School of Education, Teacher Education Program	2007

RESEARCH INTEREST

Conceptual Change Approach, Motivation, Achievement Goal Orientation, Physical Modeling, Computer Animations

FOREIGN LANGUAGES

Advanced English

HOBIES

Singing, drawing, reading, playing guitar(amateur) and tennis

WORKING EXPERIENCE

2008- 2014: TED Ankara College Foundation High School/ Ankara, Turkey

Related Teaching Duties

1. Supervisor of the High School Students for TUBITAK project
2. Integration of IB Biology Curriculum into the National Curriculum
3. Extended Essay Supervisor of IB students
4. Coordinator of University of Toronto National Biology Competition for TED Ankara College Foundation High School/ Ankara, Turkey
5. Developing Biology Education Project
6. Developing and actively participating distance education for TED Ankara College Foundation High School/ Ankara, Turkey

PROFESSIONAL TRAINING

1. METU Health Centre, Microbiology and Biochemistry Laboratory Internship: June 2004, Ankara (60 work days)

2. Internship in I.D.F. Bilkent High School: December, 2005, Ankara (One day a week, observation, 5 weeks)

3. Personal Improvement Seminar Series: October 2005, Bilkent University, Ankara

4. Internship in BUPS: February 2006, Ankara (One day a week, observation and teaching, 8 weeks)

5. Internship in TED Ankara College Foundation High School: March 2006, Ankara (One day a week, observation and teaching, 10 weeks)

6. Internship in American Collegiate Institute High School: April 2006, İzmir (2 Full weeks, observation and teaching,10 days)

7. Internship in ODTU Geliştirme Vakfı High School: October 2006, Ankara (6 Full weeks, teaching, 30 days)

8. Turkish Student Internship Project: January 2007, Iowa, Chicago, Washington D.C. (Internship in American High Schools 2 months, observation and teaching)

9. Effective Teaching Applications Symposium: March 2007, I.D.F. Bilkent High School, Ankara

10. Science Festival: April 2008, ODTU Geliştirme Vakfı High School, Ankara (jurywoman)

11. In Thinking Biology Workshop FOR IBDP Teachers: June 2009, TED Ankara College Foundation High School, Ankara (Participant)

12. Basic Statistical Applications Seminar: September 2009, TED Ankara College Foundation High School, Ankara

13. 4 th Young Innovative Initiation Project: December 2011, United State Ankara Embassy and TED, Ankara (participant)

14. 10th Annual Antalya Symposium about "Education and the Brain": February 2011, Turkey Private High School Union, Antalya

15. Scientific projects exhibition: March 2013, TED Ankara College Foundation High School, Ankara (participant as a supervisor)

16. Educational Forum about "What is educational politics?": April 2013, TED Ankara College Foundation High School, Ankara

17. Biologists in Educational Field Panel: May 2013, Hacettepe University Biology Department, Ankara (presenter)