EFFECTS OF CONSTRUCTIVIST INSTRUCTION ON THE ACHIEVEMENT, ATTITUDE, SCIENCE PROCESS SKILLS AND RETENTION IN SCIENCE TEACHING METHODS II COURSE

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Prof. Dr. Sencer Ayata
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Doctor of Philosophy.

Prof. Dr. Ali Yıldırım
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Doctor of Philosophy.

Prof. Dr. Meral Aksu
Supervisor

Examining Committee Members

Prof. Dr. Özcan Demirel	(HÜ, EBB)	
Prof. Dr. Meral Aksu	(METU,EDS)	
Prof. Dr. Ali Yıldırım	(METU,EDS)	
Assist. Prof. Dr. Hanife Akar	(METU, EDS)	
Assist. Prof. Dr. Ali Eryılmaz	(METU, SSME)	

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name : İlke ÖNAL

Signature :

ABSTRACT

EFFECTS OF CONSTRUCTIVIST INSTRUCTION ON THE ACHIEVEMENT, ATTITUDE, SCIENCE PROCESS SKILLS AND RETENTION IN SCIENCE TEACHING METHODS II COURSE

ÖNAL, İlke

Ph.D., Department of Educational Sciences
Supervisor: Prof. Dr. Meral AKSU

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The purpose of this study was to examine the effects of constructivist instruction on the achievement, attitude towards science teaching, science process skills and retention of fourth grade preservice science teachers in Science Teaching Methods II course. Two groups (one experimental and one control) were assigned from Hacettepe University Faculty of Education Department of Science Education. Experimental group consisted of 53 preservice science teachers and the control group consisted of 50 preservice science teachers; totally 103 preservice science teachers participated in this study. Quasi experimental research design was used in this study. Constructivist instruction was used in experimental group and traditional instruction was used in control group during the teaching and learning process. This research study was conducted in fall semester of the 2007-2008 academic year and lasted 15 weeks including the final examination term. Science Process Skills Test, Attitude towards Science Teaching Scale and Achievement Test in Science Teaching Methods II course were administered to participants three times; at the beginning of the study, immediately after the implementation process and 10 weeks later. A mixed between within ANOVA with repeated measures was used as a statistical technique for analyzing quantitative data and both descriptive and content analysis was used for analyzing questionnaire, formative and summative focus group interviews. Statistical mean difference was obtained for all tests in favor of experimental group and the findings of quantitative data analysis results were supported by the qualitative data analysis results. After interpreting the results, it can be claimed that constructivist instruction is effective in preservice science education.

Keywords: Constructivist Instruction, Constructivist Learning Model, Preservice Science Education, Science Process Skills, Attitude towards Science Teaching and Achievement in Science Teaching Methods II Course.

ÖZ

ÖZEL ÖĞRETİM YÖNTEMLERİ II DERSİNDE OLUŞTURMACI ÖĞRETİMİN BAŞARI, TUTUM, BİLİMSEL SÜREÇ BECERİLERİ VE KALICILIĞA ETKİSİ

ÖNAL, İlke

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Bu çalışmanın amacı dördüncü sınıf fen bilgisi öğretmen adaylarının Özel Öğretim Yöntemleri II dersi kapsamında oluşturmacı öğretimin ders başarısı, fen öğretimine karşı tutum, bilimsel süreç becerileri ve kalıcılıklarına etkisini incelemektir. Hacettepe Üniversitesi Eğitim Fakültesi Fen Bilgisi Öğretmenliği Anabilim Dalı'ndan toplam iki grup (biri deney diğeri kontrol olmak üzere) bu çalışmada yer almıştır. Deney grubunda 53 fen bilgisi öğretmen adayı, kontrol grubunda 50 öğretmen adayı olmak üzere toplam 103 fen bilgisi öğretmen adayı bu çalışmaya katılmıştır. Araştırmada yarı deneysel araştırma yöntemi kullanılmıştır. Araştırmada, öğrenme öğretme süreçlerinde deney grubunda oluşturmacı öğretim, kontrol grubunda ise düz anlatıma dayalı geleneksel yöntem kullanılmıştır. Araştırma, 2007-2008 akademik yılı güz döneminde gerçekleşmiş olup final dönemini de kapsayacak şekilde 15 hafta sürmüştür. Katılımcılara Bilimsel Süreç Becerileri Testi, Fen Öğretimine Karşı Tutum Ölçeği ve Başarı Testi çalışmanın başında, uygulama sürecinin hemen sonrasında ve

10 hafta sonrasında olmak üzere toplam üç kez uygulanmıştır. Tekrarlayan verilerde varyans analizi araştırmadaki nicel verilerin analizinde, nitel veriler kapsamında kullanılan betimsel analiz ve içerik analizi tekniği ise açık uçlu anket, süreç sırası ve sonundaki odak grup görüşmelerin analizinde kullanılmıştır. Bütün testlerin ortalamalarında deney grubu lehine anlamlı bir fark elde edilmiş ve araştırmadaki nicel bulgular nitel bulgularla desteklenmiştir. Sonuçların yorumlanmasının ardından oluşturmacı öğretimin hizmet öncesi fen eğitiminde etkili olduğu sonucuna ulaşılabilir.

Anahtar Kelimeler: Oluşturmacı Öğretim, Oluşturmacı Öğrenme Modeli, Hizmet Öncesi Fen Eğitimi, Bilimsel Süreç Becerileri, Fen Öğretimine Karşı Tutum ve Özel Öğretim Yöntemleri II dersindeki başarı

This Thesis is Lovingly Dedicated to

My Dear Father and Mother Ahmet ÖNAL and Sema ÖNAL

My Brother İbrahim Onur ÖNAL

and

My Spouse Oğuz ÇALIŞKAN

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LIST OF ABBREVIATIONS

ABBREVIATION

CBI	: Constructivist Based Instruction
CLM	: Constructivist Learning Model
TI	: Traditional Instruction
STM I	: Science Teaching Methods I course
STM II	: Science Teaching Methods II course
ÖSS	: University Entrance Examination in Turkey (Öğrenci Seçme Sınavı)
KPSS	: Public Personel Selection Examinations in Turkey (Kamu Personeli Seçme Sınavı)
TIMSS	: Third International Mathematics and Science Study
PISA	: Programme for International Student Assessment
SPST	: Scientific Process Skills Test
ASTST	: Attitude Scale towards Science Teaching
AT	: Achievement Test for Science Teaching Methods Course
PRESPST	: Pre Science Process Skills Test
PREATSTS	: Pre Attitude Scale towards Science Teaching Scale
PREAT	: Pre Achievement Test for Science Teaching Methods II course
POSTSPST	: Post Science Process Skills Test
POSTATSTS	: Post Attitude towards Science Teaching Scale
POSTAT	: Post Achievement Test for Science Teaching Methods II course
RSPST	: Retention Science Process Skill Test
RATSTS	: Retention Attitude towards Science Teaching Scale
RASTM	: Retention Achievement Test for Science Teaching Methods II course
MANCOVA	: Multivariate Covariance Analysis
ANOVA	: Analysis of Variance

F	: F statistic
N	: Sample size
M	: Mean
SD	: Standard deviation
Df	: Degree of freedom
t	: T statistic
p or Sig.	: Significance Level

CHAPTER I

INTRODUCTION

This study aimed to examine the effects of constructivist instruction on learners' achievement, retention and attitude towards science teaching in Science Teaching Methods II Course, which is offered during pre-service science teacher education. The first chapter of this thesis covers the meaning of constructivism, the reasons of the importance of using constructivist approach in teaching and learning environments, recent developments in curricula both in the world and in Turkey, the reasons of using constructivist approach in teacher education, the reasons of selection of the Science Teaching Methods II course in pre-service science education, main purpose and general characteristics of Science Teaching Methods II course. This chapter contains the theoretical background, the purpose and the significance of the study. The definitions of the important terms stated in this study are presented at the end of this chapter. The second chapter presents the review of the literature, the third chapter covers the methodology of the study, and the results of the study related to the method are presented in fourth chapter. Fifth chapter gives information about the conclusion, the recommendations for practice and further research studies.

1.1. Background

Constructivism was especially introduced to elementary education environments with the new curricula developed by the Ministry of National Education (MEB, 2004). Explaining and understanding the concept of constructivism became very important with this alteration process on education in Turkey. Turkish researchers started to do research studies regarding constructivism and their impacts on education at the beginning of 1990s. Most of the research studies were conducted in elementary level and researchers identified the implications of their studies. Suggestions and implications of the research studies about constructivism in elementary level in Turkey showed that there was a big need for conducting research studies in preservice education level related to constructivism (Uzuntiryaki, 2003; Yurdakul, 2004).

The concept of constructivism was based on the classical antiquity periods, started with Socrates's dialogues. This method consisted of directed questions that led learners to assess themselves about analyzing their thinking process. The Socratic dialogue is still an important tool for constructivist educators to assess students' learning and find clues to organize new teaching and learning environments. The meaning of constructivism can be defined in different ways by many theoreticians according to its different dimensions and aims of use.

"Constructivism is a theory about knowledge and learning; it describes both what "knowing" and how one "comes to know". Based on work in psychology, philosophy and anthropology, the theory describes knowledge as temporary, developmental, nonobjective, internally constructed, and socially and culturally mediated. Learning in this way is viewed as self regulatory process of struggling with the conflict between existing personal models of the world and discrepant new insights, constructing new representations and models of reality as a human meaning-making venture with culturally developed tools and symbols, and further negotiating such meaning through cooperative social activity, discourse and debate" (Fosnot, 1996, p.ix). This definition stresses that constructivism is a theory that explains the construction of knowledge from the philosophers, psychologists and anthropologists' aspects.

"Constructivism is fundamentally non-positivist and as such it stands on completely new ground often in direct opposition to both behaviorism and maturationism. Rather than behaviors or skills as the goal of instruction, concept development and deep understanding are the foci, rather than stages being the result of maturation, they are understood as constructions of active learner reorganization. Constructivism, as a psychological construct, stems from the burgeoning field of cognitive science, particularly the later work of Jean Piaget, the sociohistorical work of Lev Vygotsky, and the work of Jerome Bruner, Howard Gardner, and Nelson Goodman, among others who have studied the role of representation in learning" (Fosnot,1996, pp.10-11).

The constructivist approach has different dimensions which come from the behaviorism and cognitivism. Knowledge is passive and covers the reflexive responses to the external factors in the environment from behavioristic view, but cognitivists perceived the knowledge as abstract symbolic representations which are animated in the mind of individuals. Knowledge can not be transferred from one person to other; it is constructed individually by each person in that approach. The view of knowledge differs from the behavioristic and cognitivistic perspectives (CSCL, 1999).

Among the educators, philosophers, psychologists, and sociologists who have added new perspectives to constructivist learning theory and practice are Lev Vygotsky, Jerome Bruner, and David Ausubel. Vygotsky introduced the social aspect of learning into constructivism. He defined the "zone of proximal learning," according to which students solve problems beyond their actual developmental level under adult guidance or in collaboration with more capable peers (Brooks, 1993a). This zone differs from the individual properties of the children and reflects the ability of the learner to understand the logic of the scientific concept. Vygotsky claims that school tasks should be assessed by looking at interaction with adults or peers of the children. He presents that it is more viable way to look at the capabilities of the learners than investigating children's problem solving skills by individual school tasks (Fosnot, 1996). Bruner initiated curriculum change based on the notion that learning is an active, social processes in which students construct new ideas or concepts based on their current knowledge (Brooks, 1993a).

Constructivism has an interdisciplinary perspective, in as much as it draws upon a diversity of psychological, sociological, philosophical, and critical educational theories. According to this approach, constructivism is an overarching theory that does not intend to demolish, but to reconstruct past and present teaching and learning theories, its concern lying in shedding light on the learner as an important agent in the learning process, rather than in wresting the power from the teacher (Thanasoulas, 2002).

All knowledge in the world can be changed according to learners' experiences, views and they are tentative and open to improve and change according to the constructivist approach rather than teaching students to accept "what is known" simply on the basis of authority in traditional approach. Explanations of events can be changed related to different consequences or multiple causal influences. There is no one right answer for a problem so the students in teaching and learning environment should think about the alternative points. Teachers should consider taxonomy of activities and learner structures, learners' knowledge building, understanding and information. Knowledge is transformed to information according to constructivist approach in learning and teaching process. Traditional educators ignore this delivery model. Constructivist teaching models have an important role in providing meaningful learning (Beck & Kosnik, 2006).

The constructivist approach in primary education was perceived as an approach, or a teaching method. It can be used to augment, partially to replace, and usually to improve existing classroom methods. This approach is compatible with any curriculum and it can be applied in different ways by pre-service teachers according to the dynamics of the school. If more priority is given for children's own learning, more successful constructivist teaching is done (Selley, 1999).

In the 1960s, the Nuffield Science Teaching Project was put into practice. The main idea in this project was that children could understand concepts and generalizations which they would help them discover themselves. Children could organize their learnings and perform activities rather than depending on teachers' presentation. Asking critical questions, learning by living and doing and interpretation of the results were the key points of science education according to this project. This project failed because of the majority of children's confusion during the learning by doing process (Selley, 1999).

According to the United States National Curriculum documents which were developed in 2000, science is the result of developments and helps improve learners' imagination and creativity. The developmental aspect of science skills and scientific knowledge were identified in the Curriculum Guidance. This document emphasized students' everyday experiences, the importance of first hand experiences to encourage exploration, observation, problem-solving, prediction, critical thinking, decision making and discussion skills. Also, scientific procedures and attitudes towards and in science were provided in this curriculum as a vision (Ward et al., 2005).

The concept of student-centered curriculum was more emphasized in Science Curriculum 2000 in Turkey than the other curricula which were implemented before. According to Science Curriculum 2000, teacher is not the person who only transfers knowledge to the students; but teachers learn with the students, being a guide for students and providing proper teaching and learning environments. Students' role is to discover and learn the knowledge by themselves (MEB, 2000). This curriculum was changed four years later. The newly developed Science and Technology Curriculum was accepted and started to be piloted in some elementary schools in 2004-2005 academic year and started to be used all around the country in 2005-2006 academic year. The fundamental understandings and key points of Science and Technology Curriculum are;

- Less knowledge is more.
- Curriculum covers all dimensions of scientific literacy.
- Curriculum is based on Constructivist Learning Theory.

- New measurement and evaluation approaches are used in the curriculum according to Constructivist Learning Theory.
- Cognitive and physical development of students is considered in the curriculum.
- Spiral structure of curriculum is taken into consideration.
- Interdisciplinary (related with other disciplines) property of curriculum is emphasized (MEB, 2004).

Scientific literacy is an important term that is related to constructivism and is specially defined for science education. Scientific literacy is the integration of skills, attitudes, values and knowledge which consist of research, inquiry, critical thinking, problem solving, taking decision skills of people, being lifelong learners and help to improve their curiosity about science (MEB, 2005).

According to Kaptan (1999), there are five fundamental aims of science education. These are: Understanding and knowing scientific knowledge, research and discovery (scientific processes), imagination and creation, being sensitive and giving value, using and application. Scientific process skills, science-technology-society-environment relationships, attitudes and values are important aspects of Science and Technology Curriculum (MEB, 2005).

These changes in curricula also affected the pre-service teacher education. Teachers' abilities of teaching, their planning and decision making processes shaped the teaching and learning environments. Pre-service teacher education today is based on contrasting trends. On the one hand, there are promising developments: Theory-practice links, cohort groupings, teaching for understanding, reflective practice, school-university partnerships and self-study research. On the other hand, there are some cuts in funding, pressure to teach less theory, inadequate alternative certification, stifling accreditation rules, summative tests, and evaluation of programs largely in quantitative terms.

Constructivism provides a way of learning in which students are fully engaged, find the process meaningful, and relate ideas to the real world. They can participate in constructing their knowledge and acquire the habits that make them lifelong learners only in that way. Constructivism involves a similar kind of culture and experience: meaningful, critical, social, holistic at pre-service teacher education level. This is necessary so that pre-service teachers can understand what really the approach means, learn "how to do it, and grow intellectually and personally in the ways required for constructivist teaching (Beck & Kosnik, 2006). These changes indicate that research studies and revisions in pre-service teacher education are influenced by the developments at elementary level.

1.2. Purpose

Higher education Council in Turkey has done restructuring in pre-service teacher education programs according to the developments in elementary school curricula (Higher Education Council Course Definition Documents, 2006). In this renovation process, name and the content of the courses were changed also in science teacher education programs according to the application process of Science and Technology Curriculum. Science Teaching Methods course is one of the fundamental courses in pre-service science teacher education. This course which covers fundamental principles of science education and their application consists of two courses: Science Teaching Methods I and Science Teaching Methods II. According to definitions made by Higher Education Council, general principles of Science and Technology Curriculum, general characteristics of methods and techniques, measurement and evaluation processes of science education are given in Science Teaching Method I course and both methods and techniques are provided in a detailed manner. Applications are done about science teaching in Science Teaching Methods II course. The purpose of this course is to acquire all aspects of science education and apply them in elementary education level for different learning environments. According to the nature, purpose and description of the course, the meaning of constructivism and its applications related to the science education are given in Science Teaching Methods II course.

Perception of constructivism varies for some pre-service teachers' different characteristics. Kesal and Aksu (2005) conducted a study to identify pre-service students' perceptions related to constructivist principles in ELT (English Language Teaching) Methodology II course according to certain variables. They stated that the pre-service teachers' perception of the learning environment differed according to the university they were attending and their expected average score from the course. According to this result, it can be stated that the quality of education in pre-service level and organization of the course affect pre-service teachers' perceptions.

Akar (2003) stated that students' metamorphical images about teaching and learning environment changed according to student characteristics and the characteristics of their teaching and learning environment. She found that the load of writing reflective diaries, preparing portfolio tasks and the responsibility of collaborative work according to constructivist approach affect students' attitudes negatively.

Uzuntiryaki (2003) claimed that the instruction based on constructivist approach had a positive effect on the understanding of chemical bonding concepts in chemistry education. She identified that scientific process skill was a strong predictor of understanding topic of scientific concepts.

Literature findings and theoreticians' views concur in terms of views and suggestions about pre-service teacher education. Teacher educators should provide the way to help pre-service teachers think about how they learn and how they transfer their metacognition abilities into the classroom environment, provide social interactions both inside and outside the classroom, work in a collaborative way, and create their unique materials and learning environments. These are the main principles of constructivist approach in application process and it is very important to bring in creative, scientific, critical and reflective thinkers for society.

Under the light of theoreticians and researchers' findings and implications for the pre-service teacher education and applications of constructivist learning theory, lots of research studies about constructivist approach, using student-centered instructional methodologies and assessment techniques in elementary level. The implications and suggestions of these research studies revealed that effective implementation could be done with effective teachers so there was a big need for improvement in preservice education level and this could be provided by conducting research studies in this level. Because the nature and the application processes of constructivist approach could be changed according to different teaching and learning contexts (Akar, 2003; Yurdakul, 2004). Science process skills are the most important skills which could be gained to learners by constructivist learning environments in science education (Önal, 2005). According to the needs about research related to constructivism in preservice education level, the purpose of this research study was to examine the impact of using constructivist instruction on the fourth grade preservice science teachers' academic achievement, science teaching skills, attitude towards science teaching, and science process skills in Science Teaching Methods II course.

1.3. Significance

Although there are lots of studies measuring the effects of constructivist learning environments, Akar (2003) emphasized that there weren't enough research studies on the impact of constructivist teacher education on student learning and suggested conducting more experimental research studies to understand the impact of constructivist learning process on student learning in preservice teacher education specifically. Implementing a research study on the impacts of constructivist approach on some variables such as science process skills, attitude towards science teaching and achievement in preservice science teacher education can be significant and meaningful for several reasons.

Beck and Kosnik (2006) claimed that pre-service educators and school of education administrators were interested in considering ways to enhance their preservice programming. Preservice educators may obtain valuable information from the research studies about new approaches in education for different fields. Because of this, the number of studies about preservice teacher education should be increased.

Constructivism is a psychological theory of learning that describes how structures and deeper conceptual understanding come about, rather than the one which simply characterizes the structures and stages of thought or the one that isolates behaviors learned through reinforcement. The challenge for educators is to determine what this new paradigm brings to the practice of teaching (Fosnot, 1996). Constructivism is an eclectic approach which can be changed in application process according to the discipline or environment so conducting different research studies in different disciplines provide valuable suggestions for pre-service educators and program developers.

Curricular and instructional changes mandated at many levels of the countries and the world often seems arbitrary at best and poorly conceived at worst for many classroom teachers. It is an important question to determine if recent recommendations by internationally prominent scientists and science educators offer anything better than those “tried and true” practices good teachers have employed for generations. It is very important to define reflective science teacher who is successful to teach and learn in the field (Mintzes et al., 1998).

Akcay (2007) found that constructivist learning environments had a positive impact on preservice science teachers’ science-technology-society relationships and their perceptions about effective science teaching for University of Iowa College of Education students. He claimed that constructivist based learning environments motivate preservice science teachers to participate more actively in science classrooms. He suggested for conducting this research study by considering attitudes and skills of preservice science teachers. Also he concluded that conducting these kinds of research studies in different contexts is also meaningful for identifying the factors that affect the method and applications.

Many of the research studies related to constructivism were conducted in primary and elementary schools. If the research studies about constructivism in preservice, inservice teacher education and primary, elementary and secondary education levels were discussed together, meaningful suggestions can be obtained both theoretically and practically.

Scherz et al. (2005) described an instructional model for the acquisition of high order learning skills (HOLS) and the program "Scientific Communication" which supports its application in a junior high school (JHS) Science and Technology Curriculum in their study. The results indicated that the superior performance of the experimental group over the control group in the following ways: the ability to describe and explicate the practice of learning skills; three aspects of the actual performances of a complex task: knowledge and learning skills and the quality outcomes and reports produced by the students on the skills that they had acquired. The research studies on higher order thinking skills and constructivist-based instructional strategies in science education and other disciplines have a great impact on improving both higher order thinking and science process skills.

Creating constructivist interactions requires multiple activities in the classroom. These kinds of activities develop students' higher order thinking and science process skills. There is no one clue for applying constructivist instruction in classroom environments.

Providing suggestions for application of the constructivist approach in different contexts is valuable to the field of education because different applications and suggestions improve researchers' and teachers' way of thinking. Also, the century we live in is called "information age." This period requires people who use knowledge effectively, think critically, creatively and reflectively, adapt their knowledge and skills into different situations in daily life. This study can contribute to the science education and teacher education field.

Higher order thinking and science process skills which were mentioned above can be gained by student-centered instruction methodologies. Constructivism covers these strategies. Well-equipped teachers can use these instructional strategies. Well-equipped teachers could be provided by effective preservice education. Conducting more research studies could provide suggestions for effective preservice education.

Another significance of the study is that there are few studies about constructivism in Turkish preservice science teacher education. If more studies are conducted, more materials about application of constructivism in classroom environment can be obtained. Identifying pre-service teachers' needs and obtaining materials for future applications can provide important clues for program developers and researchers.

Research studies indicate that, science classes provide possibilities for students to gain higher order thinking and science process skills. Science education should be organized properly to have effective constructivist learning for gaining science process skills in an effective and permanent way. In other words, science educators should have the organization skills of providing constructivist learning environments. Science Teaching Methods II course is one of the most important ones that provide environments for pre-service science teachers to gain classroom organization skills.

This research study is also important for identifying classroom context and teachers' beliefs in detail. Understanding teachers' beliefs is very important because every researcher knows that whatever the curriculum is, teachers' beliefs will shape the classroom environment.

Briefly, Turkish education needs research studies on constructivist approach in pre-service education level and science education is one of them. The significance of this study is to examine if using constructivist approach applications will be effective on pre-service science teachers' thinking and interpreting skills of curriculum, application of eclectic strategies rather than usual and rigid ones and to show clues for constructing future educational developments. Science process skills are the most important skills which can be improved by constructivist learning environments in both elementary and preservice science education levels also. Attitude towards science teaching shapes the science teachers' future abilities and activities in classroom environments. This research study is important for preparing environments to improve preservice science teachers' science process skills and attitude towards science teaching.

1.4. Definition of Terms

Constructivism: Constructivism is an approach which consists of different instructional and assessment strategies, methods and techniques and based on learners' previous knowledge, skills and experiences for providing new learnings. This approach is mainly used for implementation process of Science Teaching Methods II course according to Yager's (1991) "Constructivist Learning Theory" for this study.

Constructivist Learning Model: Constructivist Learning Model (CLM) is a model which is based on assumptions and processes of constructivist learning theory, a naturally occurring and real-world way of thinking about learning and teaching. The teacher act as choreographer: He or she teaches basic steps, shares cultural traditions, and organizes the production, but even the youngest dancers must bring themselves to the dance and give the art form life. Experienced dancers arrange their own choreography (Gagnon & Collay, 2006; p.xiii). Science Teaching Teaching Methods II course was organized considering the main principles of constructivist learning design for experimental group. Although the content was the same for both experimental and control groups, topics were transferred to preservice science teachers by group works and interactions considering their prior knowledge. Their views were taken in the preparation process of criteria about presentations and periodical feedback was given to whole groups in experimental group.

Traditional Instruction: Classroom instruction that is based on lecturing, recitation and reading assignments. Although these settings may include pair work or group work tasks, they are dealt with from a top down perspective. Methods and techniques of traditional instruction were used for control group in this study. Researcher was the implementer in whole process in both experimental and control groups. Researcher only presented the same content as well as in the experimental group by the help of slides rather than group works and interactions among preservice science teachers during first eight weeks, after eight weeks, same science topics were presented in both experimental and control groups. Although criteria about presentation and periodical feedback were given to experimental group, no criteria about presentation and no periodical feedback were given to control group. Process in control group was teacher-oriented with no interactions among learners.

Science Process Skills: The skills which the scientists use when they are trying to understand the nature (TIMMS, 2003; OECD 2002). These are divided into two; fundamental and experimental skills. Fundamental skills include observation, classification, measurement and using numbers, making relations between space and time, estimation; experimental skills include making and assessing hypothesis, identifying and controlling variables, defining by doing, creating models and organizing and conducting experiments. Science process skill test was prepared according to these skills related to the science concepts which the all preservice science teachers should know and applied to preservice science teachers as a pre, post and retention tests.

Achievement in Science Teaching Methods II Course: This is the theoretical and practical knowledge and skills of pre-service science teachers' about general principles of Science and Technology Curriculum, problem-based and project-based approaches, creative drama method, indoor and outdoor activities which are interactive and mostly used in science education, measurement and evaluation process in science education. Achievement test was prepared by the researcher to apply to preservice science teachers as pre, post and retention tests for identifying their knowledge and skills about teaching, learning, measurement and evaluation approaches, methods and techniques in science education in this study.

Attitude Towards Science Teaching: This scale consists of 11 positive statements and 10 negative statements and was developed by Thompson and Shringley in 1986. This is a five-point likert scale covered general perceptions about science teaching, student characteristics, relationship between science and other topics. Scale measures how the preservice and inservice teachers feel themselves in science education. This scale was adapted to Turkish by Özkan, Tekkaya and Çakıroğlu (2002). The cronbach alpha reliability coefficient of the scale was calculated as 0.83. This scale was applied to pre-service science teachers as a pre, post tests in this study.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter consists of two main parts. In the first part, historical background of constructivism, constructivist teaching approaches, constructivism in classroom environments, learner and teacher roles in constructivism, science education and preservice education related to constructivism were discussed. The next part covers the research studies related to constructivism, constructivist instruction and assessment strategies, use of constructivism in science education and preservice education, science process skills and higher order thinking skills in science education in both abroad and in Turkey. Summary of the review of literature and its implications for this study were given at the end of this chapter.

2.1. Historical Background of Constructivism

As a theory, constructivism has two major historical sources. One source is philosophical, a general theory of knowledge that can provide background and support for more specific educational theory and practice. The other source is the experience of reflective practitioners, teachers and those who seek to help and learn from them. A third source, growing in recent times, is a Professional research community, seeking to bring theory and practice more coherently together. Plato learned the theory by following the teaching practice of Socrates. Socrates taught, for the most part, by insightful questioning that helped others “reduce to order” their own stil fragmentary knowledge. In the Meno, Socrates induced an untutored slave boy, by honest questioning, to establish the Pythagorean Theorem. For modern times, Immanuel Kant claimed that scientific knowledge was actively constructed from our observational experience. For Kant, the metaphor of construction was pointedly appropriate. His organization of categories-a basic system of questions that inquiry must ask of nature-guides people in an ongoing process of constructing, testing and reconstructing explanatory hypotheses. The acceptance of Kant's view of knowledge as a constructive process led to further issues. One of the example is Thomas Kuhn's (1970) well-known work in which he carefully analyzed historical shifts in the presuppositions of scientific investigation and thought (Hawkins, 1995).

A contemporary explicit proponent of "constructivist" relativism, known to educational researchers, was Ernst von Glaserfeld (1984). Kant did, indeed, say we could not know nature as "the thing in itself", but only as humanly qualified. But he did not intend a great mystery condemning us to our own parochial views; he was simply pointing out aganist the rationalistic philosophy of his times-that this prohibition was one of simple logic. At the turn of the century, this movement encountered a major theorist and supporter in the person of John Dewey. The school itself, he often argued, was the necessary laboratory in which practice could be distilled as theory and theory reduced to altered practice. Marching under the banner of Dewey's philosophy, however, "progressive" schools sometimes earned their disrepute because they fell into the laissez-faire belief that children would pursue their own learning without responsive adult participation. In his last major writing on education, Dewey (1963) recognized that he had been lax in not insistently emphasizing the essential role of investigative teachers: in scouting out the diverse talents of individual children; in recognizing their available pathways of entry into important subject matter; in evolving relevant resources; in furthering children's potential contribution to the vitality of classroom life (Hawkins, 1995, pp. 9-12).

When looking at the historical foundations of constructivism, it can be said that this approach becomes to be used for human and society recently and application fields of constructivism in education increase today. After reviewing historical foundations, it will be useful to explain the concept of constructivism according to meanings.

2.2. Constructivist Teaching Approaches

If students come to lessons with ideas about their world which already make sense to them, then teaching needs to interact with these ideas, first by encouraging their declaration and then by promoting consideration of whether other ideas make better sense. A feature of constructivist approach to science teaching is that the outcomes can be different for different students. Some may want to explore a concept in considerable detail and will develop understandings closer to those of scientists, while others will be more interested in exploring practical and personal aspects of the topic. This diversity of outcome poses problems for teachers. The outcome from traditional science lessons is also diverse, through assessment procedures that rely heavily on recall and rote learning conceal them. When understanding is probed at a deeper level, the learning is often found to be superficial, even for students who are described as very successful. The problem for learners who are described as successful is that they are often unaware of the partial nature of their development of a particular concept, and have difficulty in contemplating change to their ideas. Procedures in which there is more conversation about learning provide a better base for further learning. The open negotiation of meaning, and appreciation of the partial nature of the learning achieved, also model a better image of science (Carr et al., 1995, p.150).

There are four aspects of teaching science which is informed by a constructivist view of learning. These are:

1. There is no unique method or instructional route to teach a particular topic from a constructivist perspective.
2. Learning science involves not only coming to terms with new conceptual structures but also developing a new rationality for knowledge. This rationality values decontextualized rather than situated knowledge; it values explanations which can be generalized to many contexts rather than those which are limited and ad-hoc in nature. It rather demands internal consistency of theories.

3. The teaching involves establishing an argument for the science view which is likely to involve empirical findings, but it goes beyond these in helping students to construct the particular "ways of seeing" adopted by the science community. The teacher develops a narrative of introduction to the science view in which supportive evidence is drawn upon preferentially and new modes of expressions are rehearsed through discourse in the classroom. Learning science involves socialization into a particular way of looking at the world. It is not a matter of discovering "how the world really is;" the science view is not simply there to be "seen" in the real world. This highlights a very important distinction between discovery learning and constructivist approaches to learning. Since the science view itself is socially constructed within the science community, learning science requires students to be socialized into a "new way of seeing," which means that they need to be enculturated into the science community.
4. Teaching informed by a constructivist perspective recognizes that both practical activities and the discussion of these may be interpreted by students in ways which differ from those intended. Even when arguments have apparently been clearly developed through classroom discourse, this does not mean that individuals have made sense of them. Teaching must involve a process of regular feedback and checking to identify the reasoning students are using so that teaching activities can be adjusted accordingly (Scott, Asoko, Driver, & Jonathan, 1995, pp.218-219).

The roles of teacher are very important in constructivist approach. Teachers' beliefs and roles shape the learning environment. The roles of both novice and experienced teachers in constructivist approach were explained below.

2.3. Teacher Responsibilities in Constructivist Learning and Teaching Environment

Newly qualified, novice teachers can try to select the content to match the pupil's needs instead of accepting a prescription (from textbook, teachers' guide or any printing curriculum) of what exactly is to be taught. This can initially be done at the whole class level;

- Considering what the children have recently shown an interest in,
- With regards to any proposed task, judging whether the skills that will be required are the ones which most of the children can reach, but which they need to practice. This more systematic elicitation of individual children's existing knowledge and understanding of a concept will usually be revealing in two ways: 1) a wide variety of views, and the range of sophistication; and 2) the great chasm between what many children know (or think they know) and what an educated person is expected to know (Selley, 1999, p.15).

The teacher who is comfortable with all the necessary techniques of planning, organization, control of the class and of time may feel that the pupils' learning still leaves something to be desired. This disquiet may take the form of a recognition that pupils have become too dependent upon spoonfeeding. That is, they want to be told exactly what to do and what to learn. Another source of disquiet may be that although the pupils do what is expected of them and complete their tasks or exercises accurately, they do not provide their own ideas, and do not extend or apply what they learn in any personal way (Selley, 1999, pp.17-18).

Yager (1991) claimed that many exemplary teachers instinctively use many procedures that illustrate the Constructivist Learning Model (CLM). Some of these include:

1. Seeking out and using student questions and ideas to guide lessons and all the instructional units;
2. Accepting and encouraging students' initiation of ideas;
3. Promoting student leadership, collaboration, location of information, and taking action as a result of the learning process;
4. Using student thinking, experiences, and interests to drive lessons (this means frequently altering teachers' plans);

5. Encouraging the use of alternative sources for information both from written materials and experts;
6. Using open-ended questions and encouraging students to elaborate on their questions and their responses;
7. Encouraging students to suggest reasons for events and situations, and encouraging them to predict consequences;
8. Encouraging students to test their own ideas, i.e., answering their questions, their guesses as to reasons, and their predictions of certain consequences;
9. Seeking out student ideas before presenting teacher ideas or before studying ideas from the textbooks or other sources;
10. Encouraging students to challenge each other's conceptualization and ideas;
11. Using cooperative learning strategies that emphasize collaboration, respect individuality, and the use of division of labor tactics;
12. Encouraging adequate time for reflection and analysis; respecting and using all ideas that students generate; and Encouraging self-analysis, collection of real evidence to support ideas, and reformulation of ideas in light of new experiences and evidence.

2.4. Constructivism in Classroom

In constructivist classroom, students actively participate in learning acquisition, and engage in restructuring, manipulating, and experimenting with the knowledge to make it meaningful, organizing and permanent. Thus, learners are active in learning process. Teachers acts as a facilitator rather than as an authority. In such a classroom, collaboration and group activities are encouraged (Yager, 1991).

A constructivist learning environment differs greatly from traditional learning environment. The table below shows the basic differences between a constructivist classroom and a traditional classroom.

Table 2.1

Characteristics of constructivistic learning environments compared to traditional science teaching learning.

Traditional Classroom	***Constructivist Classroom***
*Students primarily work alone	*Students primarily work in group
*Curriculum is presented part to whole, with emphasis on basic skills	*Curriculum is presented whole to part with emphasis on the big concept
*Strict adherence to a fixed curriculum is highly valued	*Pursuit of student question is highly valued
*Curricular activities rely heavily on textbooks and workbooks of data and manipulative materials	*Curricular activities rely heavily on primary sources
*Students are viewed as “blank slates” onto which information is etched by the teacher	*Students are viewed as thinkers with emerging theories about the world
*Teachers generally behave in a didactic manner, disseminating information to the students	*Teacher generally behave in an interactive manner mediating the environment for students
*Teacher seek the correct answer to validate students lesson	*Teachers seek the student’s point of view in order to understand students learning for use in subsequent conceptions
*Knowledge is transmitted, external to learner, objective, stable, fixed	*Knowledge is constructed, emergent, situated in action and experience, distributed
*Learning is knowledge transmission, reflecting what the teachers knows, well-structured, product-oriented	*Learning is knowledge construction, interpreting world, constructing meaning, authentic-experience, process oriented
*Assessment of students learning is viewed as separate from teaching and occurs almost entirely through testing	*Assessment of students learning is interwoven with teaching and occurs through teacher observation of students at work and through exhibition and portfolios

Source: *Brooks & Brooks (1999b), p.17.*

In a constructivist classroom, the teacher behaves as a guide and provides a bridge for the students to combine the previous learning and new-learning. The students are encouraged to develop such meta-cognitive skills as reflective thinking, creative thinking, independent learning and problem solving. So, the students in a constructivist classroom are able to develop meta-cognitive skills.

As for evaluation, constructivism suggests that teachers use authentic evaluation methods rather than just use paper pencil test. This kind of assessment procedures emphasizes process, in which the constructivist approach is interested, rather than the outcome.

2.5. Constructivism and Science Teacher Education Programs

Yager (1991) stated that if Constructivist Learning Model (CLM) were to achieve the impact it aimed to, it would require, basic reforms in science teacher education to be contemplated. Teacher education is widely criticized as ineffective. As emphasized about how students learn, it seems that educators should utilize these same techniques in programs designed to prepare new teachers as well as the techniques designed for inservice of teachers.

When the constructivist model is used, the following statements will characterize science teacher education programs:

- The programs will be largely school-based since they are more effective than college-based programs when dealing with complex behaviors;
- Teachers will actively participate in planning while program objectives are determined;
- Self-instruction will be often in evidence;
- Individualized instruction will be seen as more effective than age-group instruction is;
- Teachers will have an active role in all aspects of the program;
- Program will emphasize demonstrations, trials, feedback, and give and take;
- Students, teachers, and leaders will share and provide mutual assistance;
- Programs will be directly linked to general effort of the school (Yager, 1991).

Yager (1991) characterized inservice teacher education activities that utilize Constructivist Learning Model (CLM). They are as follows:

- Inservice education in which matters involve conceptual change on the part of teachers;
- When the thrust of the inservice program is towards constructivist perspectives on teaching and student learning, the change involves teacher's conceptions of learning and teaching;
- Conceptual change in teachers is the most considered helpful in terms of whether or not new ideas are intelligible, plausible, fruitful, and feasible;
- The conceptions held by teachers on attending an inservice program will sometimes include ideas and beliefs about the focus of the program that are in conflict with the ideas and belief of those running the program;
- Inservice, wherever possible, must model, but not mimic the strategies and ideas being advanced;
- Different groups will attend inservice programs with different levels of relevant knowledge and experience; and
- Those conducting the inservice program must be sensitive to their own needs as they may undergo conceptual change.

Researchers summarized that constructivism is an important approach in elementary, preservice and inservice science education. Organizing learning and teaching environments according to constructivist learning principles such as asking critical and reflective questions, considering learners' prior learnings and providing conceptual change according to prior concepts, giving importance to self instruction, individualized instruction, also group working. All the learners should actively participate the learning and teaching processes. Applying constructivist principles depends on the characteristics of general school standards, characteristics of the learners and teachers, the shape of teaching and learning environments, materials.

2.6. Research Studies Related to Constructivism Abroad

This part includes the research studies on using constructivist instructional strategies in science education, science teacher education, constructivist assessment techniques in science education, the importance of scientific literacy in science education, science process skills in science education, teacher thinking, teacher decision making and teacher planning processes in science education.

2.6.1. Research Studies on Using Constructivist Instructional Strategies in Science Education

Andersson and Wallin (2006) analyzed a research program for the improvement of science teaching. The idea of the program was that researchers in science education and teachers in schools had better work together to design teaching sequences and to assess how they functioned in practice. The results of the study showed that the most important product of the design was that it was a detailed guide for teachers, which they looked upon as a tool for further knowledge construction. According to the results of the study, the researchers suggested that the idea of domain-specific theories be worth examining and developing. It might also contribute to strengthen science education as an autonomous discipline.

Connoly and Beqq (2006) conducted a study about database systems for undergraduate and postgraduate courses which were related to computer science and information systems. They examined reflections on the difficulties of the data base design and described a teaching approach motivated by the principles found in the constructivist epistemology to overcome these difficulties and to provide the learner with the knowledge and higher-order skills which were necessary to understand and perform database analysis and design effectively as a professional practitioner. The research consisted of 977 students. These students divided into three groups, one of which used the constructivist project-based approach albeit through online delivery. The student feedback was obtained from end-of-module questionnaires and faculty feedback from interviews. Generally, student feedback was positive and all the students claimed that they had enjoyed the experience. They also appreciated that this approach provided them with relevant work experience that could help their employment prospects on completion of the course. The students were also very receptive to the concept of a reflective journal and, while it was sometimes difficult to find tile time to maintain it, many reported that they had benefited from this approach and would keep a reflective journal for the remainder of their studies and into employment. However, most students reported that the workload was significantly higher than in other modules. They also added that time management was an issue, particularly as they had no real feeling at the outset of scope and complexity of the projects they had selected. All of the students agreed that the approach should be extended to other modules, without having a project per module. They suggested that one assessment based integrative project that extended over a number of modules would be an extremely powerful approach to teaching and learning. Extended qualitative analysis and using portfolio were suggested to use data base effectively by the researchers.

Leach, Ametler, Hind, Lewis and Scott (2005) conducted a study to verify the feasibility of designing short teaching sequences, and which based on insights from research and scholarship on teaching and learning science, which were measurably better at promoting conceptual understanding amongst students than the teaching approaches usually used by their schools. The research team consisted of 9 teachers (3 biology, 3 chemistry and 3 physics) to design, implement and evaluate 3 teaching sequences in which there were students who were between the ages of 11-15. The findings showed that the use of authentic assessment questions and student-centered instructional strategies increased students' motivation and changed students' perception in a better way in science education.

Osborne (2005) conducted a study which had two phases. The researcher worked with a group of 12 science teachers in the first phase. The main purpose was to develop sets of materials and strategies to support argumentation in the classroom, and to support and assess teachers' development with teaching argumentation. In phase 2, teachers taught the experimental groups a minimum of nine lessons and a comparison group at the beginning at the end of the year. The results showed that argumentation was an effective strategy and argumentation in scientific context was more difficult than that in a socio-scientific context.

Davies (2003), in article of “Pragmatism, Pedagogy and Philosophy a Model of Thought and Action in Action in Primary Technology and Science Teacher Education” evaluated the influence of teachers’ prior educational experience and beliefs about the relationship between design and technology and science on their lesson planning during school placements. As a part of research project at Goldsmith’s College, London, he studied a sample of 126 pre-service primary teachers over three successive cohorts and they were given questionnaires to elicit their beliefs concerning the relationship between science, design and technology in society and in the curriculum. The results showed that sharing philosophy and pedagogy rather than focusing entirely on pragmatic concerns, enabled preservice teachers to move between contexts without experiencing so a profound dissonance between their espoused theories and practice.

McKeown (2003) conducted a research study to explain some basic issues and complexities associated with working with K-12 administrators, teachers and students. The researcher described current pedagogical strategies for science education as well as learning modalities and the importance of engaging students in each modality. The article included an interview with Charles Hopkins, a former superintendent of curriculum and instruction, who gave insightful examples of individuals and groups from outside, the school system trying to influence curriculum adoption and implementation. For the curriculum competition, his suggestions included writing a budget for associated teacher training and following up materials and evaluation; for the heavy workload of teachers, forming an advisory group of teachers to develop materials that would reduce review and preparation time; for the learning styles of students, creating programs that engage students of all learning modalities, and identify this feature in the project description and promotional literature; for age and developmentally appropriate materials and programs, designing a science education program beforehand, learning about the intended audience, including the students’ cognitive level of development; for the sound science pedagogy, using proven methods of effective teaching such as hands-on science and discovery when designing educational programs; for the importance of achievement test scores, pilot testing test new materials and analyzing standardized achievement test scores or other measures of achievement to determine the new program's effectiveness; for proposal clearance, consulting with organization partners with a school in a proposal early in the planning process to find out what sort of lead time they needed to get internal approval; for conversation with a superintendent of curriculum and instruction, beginning dialogue early with a school system that the researchers wanted to work with and offer to co-develop materials.

Stenger and Garfingel (2003) conducted a study lasting two months. A classroom of fifteen language minority first graders participated in an open-ended constructivist project with the aim of fostering critical thinking skills, creating independent and motivated learners, and meeting the state of Virginia Schools. Individual student conferences, photos, group discussions and reflections, surveys, and formal assessment were used to report the project. At the end of the project, it was found that students were engaged in the constructivist approach to learning.

Tytler (2002) provided some clues about teaching methodologies for constructivist, conceptual change of students. The research on student learning of science conceptions was reviewed and the major findings were presented. Generative learning model and interactive approach were compared and some suggestions were provided to the educators such as providing students with the opportunities to express their own ideas and providing experience which could relate to students' prior ideas. Identifying the students' needs and being aware of their characteristics would help to organize creative and effective environments for meaningful concept learning.

Thompson and Soyibo (2002) investigated whether the use of combination of lecture, teacher demonstrations, class discussion and student practical work in small groups significantly improved the experimental subjects' attitudes towards chemistry and understanding of electrolysis more than their control group counterparts who were not exposed to practical work and whether there were statistically significant differences in their performance on electrolysis linked to their treatment, gender and post-test attitudes to chemistry. The results showed that there were statistically significant differences between the experimental and control group, in favour of the former one.

Gary (2001) conducted a research project that determined the measurement of learner characteristics, learner perceptions of the classroom and constructs of the learners. The research study showed that the issues related to the assertion that attainment and retention of knowledge and understanding by students in a middle school science classroom could be achieved with the application of constructivist epistemology. The Learning Environment Survey was used as a measurement tool for this study. 29 students' responses used for data analysis for the study and although the participants' response did indicate that the researcher had yet to teach in a fully constructivist manner, it was required that they feel more confident about the design and assessment of the teaching and learning process. The paper and pencil test and concept plan showed a variety of prior constructs in this unit of study. Following the unit of study, the diversity of constructs had been narrowed and the western construction of scientific knowledge and understanding regarding cosmology and astronomy had been successfully hidden out in the student's cognitive structures.

Simon (2001) analyzed the problems inherent to identify the attitude of a major force in American psychology and education in this study. This study was conducted to provide a structure for identifying constructivist thought by sifting out five tenets to which constructivist theories subscribed. With these tenets as an organizing framework, Bandura's two major theoretical treatises were analyzed, Social Foundations of Thought and Action: A Social Cognitive Theory and Self-Efficacy: The Exercise of Control, as well as several conceptual articles to discover the paradigmatic assumptions that underlined his social cognitive theory. Results of this study's analysis stated that Bandura's major theoretical tenets, key contentions, and psychological constructs were not only consistent with social constructivist thought, but were also antagonistic towards mechanistic, positivistic, or behavioral views of human functioning. It concluded that an accurate interpretation of Bandura's work was critical to informed teaching, research, and scholarship.

Tsai (2000) conducted a study to measure the interplay between students' scientific epistemological beliefs and their perceptions of constructivist-learning environments. 1.176 Taiwanese tenth grade students participated in the study and provided answers to the questionnaire. The main results of this study showed that teachers needed to be aware of students' epistemological orientation towards scientific knowledge, and to complement the preferences during the designing process of learning experiences, especially providing constructivist-based lessons to enhance science learning for students who were epistemologically constructivist oriented.

Freedman (1998) used constructivist theory and the goals and tenets of the Iowa SS&C (Scope, Sequence, and Coordination) project as its framework in his study. Three constructs were found from the literature related to constructivism and its implications for the learning environment. These were (1) learning was an active process, (2) the learner had prior knowledge, and (3) the learner took responsibility for their own learning. The purpose of this study was to explain the assessment environment and practices were presented in Iowa Scope, Sequence, and Coordination (Iowa SS&C) and other Iowa science classrooms (IST). Nine teachers from the Iowa SS&C sample and eight teachers from the IST sample participated in this section of the study. Semi-structured interviews were conducted and these interviews consisted of four main questions. The constant comparative method following a grounded theory model was used for data analysis process. The main results of the study were i) the assessment environment could be described by teachers, ii) a variety of assessments were used to determine a student's grade and iii) higher order thinking skills were an integral part of Iowa SS&C teacher assessment items.

Tim and Brian (1996) conducted a study to explain the barriers to understand the relationship with teaching and learning science among children. They stressed the assertion that children could operate in a number of cognitive models or styles of thinking; indicative role played by language in teaching; role of experience in building concepts; and implications for teachers. According to the literature and their observations, they reviewed the literature and emphasized that the cognitive basis of children's alternative conceptions in the science content area of light and sight and they discussed three problems beating on teaching and learning in science. They claimed the these barriers for understanding of the 'school science' account of phenomena were related to the fact that children could think about science using different modes of cognitive functioning. The three problems had to do with the ambiguity of language, the connection between our experiences and our concepts and the divide between everyday knowledge and school knowledge. They provided some suggestions related the teaching and learning environment for effective learning.

2.6.2. Research Studies about Constructivism in Science Teacher Education

Akcay (2007) conducted a research study to examine the effect of a Science-Technology-Society (STS) course for preservice science teachers on perceptions, attitudes of preservice science teachers. The Course focused on the changes in pre-service science teachers related to the effectiveness of a STS/Constructivist learning environment. Both qualitative and quantitative research methods were used in this study. This study was a one group pretest-posttest design. The instruments were applied to the pre-service science teachers at the beginning of the semester as pre-tests and as post-tests at the end of the semester. The sample consisted of forty-one preservice science teachers who participated in the Societal and Educational Applications of Biological Concepts course during the spring semester of the 2004 and 2005 academic years at the University of Iowa.

The major findings of the study included the following results; i) Preservice science teachers showed significantly better results in their perceptions about STS/Constructivism, beliefs about science teaching and learning, attitudes toward science and technology, and their implications for society. ii) Preservice science teachers understood how students learned with STS/Constructivist approaches. They also increased their use of STS/Constructivist approaches which were developed and applied to teaching science for all students, iii) Pre-service science teachers showed statistically significant growth toward a STS/Constructivist philosophy of science teaching and learning in terms of student actions in the classroom as well as their increased understanding of science process and content; iv) STS/Constructivist Approach provided student-centered learning environments that were relevant, motivational and meaningful for preservice science teachers.

Hartle (2007) studied certain participants in an NSF funded GK-12 fellowship program in his dissertation study of "A Collection of Research Reporting, Theoretical Analysis and Practical Applications in Science Education: Examining Qualitative Research Methods, Action Research, Educator-Researcher Partnerships and Constructivist Learning Theory". The program was qualitatively studied to identify and to characterize the cultural factors that influenced the relationships between the educators and researchers in their partnerships. These factors were organized into ten critical axes. An axis was defined as a range of attitudes, behaviors or values that were defined by two stereotypical extremes. The research results indicated that college science teachers, educational theorists and educational researchers could all communicate about constructivism from their own perspectives, by using common language and ideas.

Grosshans (2006) conducted a research study entitled as "Science Teachers. Understanding and Use of Instructional Strategies Within the 4 x 4 Block Schedule" to investigate how science teachers could engage students under the 4 x 4 block schedule and to identify the teachers' understanding of how they used instructional strategies for influencing their lessons. The research suggested that block scheduling provided more time for teachers to incorporate varied strategies such as inquiry-based and cooperative learning teaching which had philosophical roots in a social constructivist philosophy. This research investigated the questions of which instructional strategies science teachers used to engage students on the 4 x 4 block schedule, how science teachers understood their use of instructional strategies. The methodology was qualitative and involved a multiple case study of three high school science teachers at a large rural county high school. Data sources were pre-observation interviews, classroom observations, post-observation interviews, and the collection of documents and artifacts such as lesson plans, student hand-outs, worksheets, laboratory exercises, homework and other documents which the teacher used to prepare for implementing a lesson. The researcher suggested that the strategies used by these three science teachers remain mostly didactic in nature. Although the teachers reported in the interview phase of this research that they used a wide variety of strategies, what was observed within the 4 x 4 block structure was the use of different didactic strategies, not different holistic strategies. Although the teachers were aware of more holistic strategies such as inquiry-based and cooperative learning, they were neither adopted nor adapted within the lesson. The three teachers used strategies that were consistent with their scientific realist views concerning the nature of science.

Rebello and Fletcher (2006) conducted a case study which provided professional development to advanced undergraduate and graduate research team members of the Kansas State University Physics Education Research (KSU-PER) group. An integral component of a student's professional development was the opportunity to participate in a range of research activities and work in collaboration. In order to coordinate and facilitate these opportunities KSU-PER established an ongoing research project investigating students' conceptions of the physics underlying devices. The method consisted of combining elements from grounded theory, phenomenology and action research. The framework provided a forum and research setting allowing junior and experienced researchers to act in various project management roles and perform a range of research activities. The results of the study indicated that while most students appeared to have benefited from the focus on qualitative research methodologies and how they could be applied to their research, at least a few students continued to seek a recipe-based sequence of steps.

Erduran et al. (2005) conducted a study to examine the pedagogical strategies necessary to promote argumentation skills in students, determine the extent to which the implementation of such strategies enhances teachers' pedagogical practices with argumentation and examine the extent to which lessons that followed these pedagogical strategies led to enhanced quality in students' argumentation. Data collected from a set of lessons on scientific and socio-scientific topics from twelve year 8 schools in London were analyzed, reported and discussed. There were statistically differences in the quality of arguments generated in the classrooms of the project teachers who had participated in the training workshops.

Goodnough (2005) conducted a study to gain in-depth understanding of plan and implementation process of problem-based learning, using a student-centered approach to teaching and learning with constructing open ended problems. The research related with primarily on the issues and concerns that arose as the researcher developed and implemented a modified form of traditional PBL (Problem Based Learning) in large, preservice science teacher education classes. The research questions were 1) How can PBL be used to foster an inquiry-based approach to pre-service preparation? 2) How will students perceive PBL as a means of learning? and 3) What challenges will the researcher encounter when developing and implementing a PBL curriculum? Different data collection methods and sources which consisted of field notes, semi-structured interviews, student-generated documents, and student journals were used in this study. The research results showed that using modified PBL with large groups was challenging because of the difficulty, with only one instructor in the classroom, in ensuring groups function effectively. The outcomes of the study described challenges which were problem development, facilitation of groups, and assessment. These were encountered by the researcher as she planned for and implemented PBL. Changes in the researcher's classroom practice, the connection between these changes and constructivist learning principles, and implications for science-teacher education were addressed.

Hudson (2004) investigated constructivist theory and the five-factor model (pedagogical knowledge, system requirements, feedback, modeling, and personal attributes) for specific mentoring might assist the development of mentees' primary science teaching in his article. It was stressed that constructivist theory complements field experience models which allow mentors to build upon the mentee's prior understandings towards developing knowledge and skills for science teaching firstly. The picture that emerged from the literature showed five factors for effective mentoring that might be used as a model for specific subject areas secondly. Personal attributes that the mentor needed to exhibit for constructive dialogue; system requirements that focused on curriculum directives; competent pedagogical knowledge for articulating best practices; modeling of efficient and effective practice; and feedback for the purposes of reflection to improve practices were explained as the factors in the study. Specific mentoring strategies associated with each factor needed to be designed to guide mentoring in specific subject areas such as primary science. This could be used as a form of professional development for the mentor in the dual roles as teacher and mentor.

2.6.3. Research Studies about on Constructivist-Based Assessment Techniques in Science and Science Teacher Education

Cowie (2005) conducted a research study and collected data obtained from student interviews and classroom observations for presenting student perceptions of their assessment in science lessons. The results showed that the use of a socio-cultural lens to make sense of student perceptions and experiences of classroom assessment had reinforced the central and crucial importance of teacher, student, and subject interactions in science education and emphasized the complexity of their impacts.

Roberts and Gott (2004) conducted a research study to describe a written test for procedural understanding. This test was given to 15 year old students. Comparisons were made between the scores on a written test of procedural understanding with both assessments which were made of subject knowledge and pupil accounts of investigations. The researchers claimed that this kind of test was any way a replacement for either a practical or a paper and pencil problem solving task in which the ideas were synthesized to solve the problem and this model of assessment devolved responsibility for teaching activities to the teachers in the result part.

Gott and Duggan (2002) wrote an article to present an overview of the problems associated with the assessment of practical work in science. They identified two theoretical positions from which different emphases for teaching and assessment flow and examined some of the available evidence on possible methods of assessment which articulate with these two positions which are process and product based assessment works. The results of the study showed that providing practical ability to solve science problems creatively, investigate and interpreting the results of them were necessary.

2.6.4. Research Studies on the Importance of Scientific Literacy in Science and Science Teacher Education

Kim (2005) conducted a research study to investigate the system of thinking paradigm and current science education in a theoretical view and to discuss its implications with information technology. It was a theoretical and philosophical research and was divided into three parts: firstly significant trends in science education during the late 20^{th} century were examined, secondly, the nature of thinking paradigm was discussed with a specific focus on system thinking and thirdly, the implications of the system thinking paradigm were discussed in relation to science education. The following results were found in the study; i) scientific literacy had emerged as the major goal of science education in the age of information, ii) the current thinking paradigm was changing from analytics to systemics in that it is concerned with interrelated components and systems as the property of the whole and iii) in terms of applications in science education, system thinking could be interpreted as the essential form of scientific literacy.

Shive (2005) conducted a research in doctoral study to create a model for the students to gain scientific literacy and this model consisted of content knowledge, science process skills and attitude towards science. The results of the study showed that the total effects were the greatest for the teachers' attitudes followed by the schools' contexts and instructional practices.

Kjaernsli and Lie (2004) did research on the similarities and differences between the Nordic countries concerning patterns of competencies defined as scientific literacy in the Program for International Student Assessment (PISA) study. The results showed that the magnitude of the gender differences in achievement varied considerably between the five Nordic countries, with a strong relative advantage for boys in Denmark compared to its Nordic neighbors and there seemed to be no common Nordic pattern to the data on students' relative strengths in process skills or conceptual understanding. These similarities and differences were obviously caused by the interplay of curricular, language and more general cultural factors.

Scientific Literacy is an important term which covers both learning and teaching abilities in science. This term includes also both fundamental and experimental (procedural) science process skills. Scientific literacy were emphasized in Science and Technology Curriculum 2004 as an important quality for science learners. Effective preservice teachers should have the ability of scientific literacy for providing their students as scientific literarers.

2.6.5. Research Studies on the Importance of Science Process Skills in Science and Science Teacher Education

Scherz et al. (2005) described an instructional model for the acquisition of higher order learning skills (HOLS) and the program "Scientific Communication" which supported its application in a junior high school (JHS) Science and Technology Curriculum in their study. 447 students participated in this study. 334 of them participated as the experiment group and used the new instructional model and 113 of them participated as control group and newly developed instructional model was not used in this group. The results emphasized the superior performance of the experiment group over the second in the following ways: the ability for describing and explicating the practice of learning skills; three aspects of the actual performances of a complex task; knowledge and learning skills and the quality products and reports by students on the skills that they had acquired.

Harlen (1999) showed the importance of approaches to provide skill assessment for three purposes, formative, summative and national-international monitoring. Researcher emphasized that the research studies showed that in all cases the assessment of skills was influenced not only by the ability to use the skill but also by knowledge of and familiarity with the subject-matter with which the skills were used. Assessment in any particular situation was a combination of skills and knowledge and various steps had to be taken if these were to be separated.

2.6.6. Research Studies on Teacher Thinking, Decision Making and Planning Processes in Science and Science Teacher Education

Sercoussi (2005) conducted a research study to examine the relationship between the teachers' perceptions and implementation of inquiry-based instruction as well as their students' perception and performance on inquiry-based activities. The research questions were 1) how do teachers perceive and implement inquiry-based teaching and how teachers' beliefs about student learning are reflected in their pedagogy, were used to guide this study. A group of six science teachers and their students from grades 7 to 12 participated in the study. A mixed methodology was utilized for both qualitative and quantitative. Data from surveys of teachers, students, classroom observations and interviews of teachers and students were analyzed and then categorized into similar groups and subgroups in order to answer the research questions. The results showed that teachers showed a continuum of inquiry instruction which was related to their pedagogical practices. Another finding was that student had little say into what occurred in the classroom. Also there was a disagreement between the surveys and the interview data which illustrated the usefulness of using a mixed methodological approach.

Welch (2004) conducted a research study to investigate teachers' perceptions of informal science professional development to gain an in-depth understanding of the essence of the phenomenon and related science-teaching dispositions. The dissertation data were collected from eight middle school teachers purposefully selected because they had participated in informal programs during Project TRIPS (Teaching Revitalized through Informal Programs in Science). Several methods were used to increase the credibility of the research, including using triangulation of data. The interviews were transcribed, color-coded and organized into six themes that emerged from data. The themes includes a) internalized content knowledge, b) correlated hands-on activities, c)enhanced science teaching disposition, d) networking/camaraderic, e) change of context and f) acknowledgement as professionals. The teachers identified supportive elements and constraints related to each theme.

The results indicated that programs offering experiential learning opportunities strengthened understanding of content knowledge and also the results illustrated how informal educators could use this cohesive model as they developed programs that addressed the supports and constraints to teachers' science instruction needs.

Haney, Lumpe and Czerniak (2003) conducted a research study to identify and analyzing the perceptions of teachers, administrators, parents, community members and high school students about the science learning environment. Their research questions were; 1) What are the beliefs of the teachers and other school community members about the science learning environment and 2) How do these beliefs structures compare? Seventy two participants of a year-long Eisenhower-funded grant project were purposely selected for this study. Varrella and Burry-Stock's (1997) Beliefs about Learning Environments (BALE) was used as a theoretical model for constructivist belief identification and comparison. BALE responses were rated using the BALE rubric, which consists of a 1 to 5 point system, with 5 representing a response highly constructivist in nature. Analysis of BALE responses showed that the administrators and teachers possessed the most constructivist beliefs. The researchers suggested that identifying the beliefs of teachers, as well as those of the entire school community, was crucial.

Plourde and Alawiye (2003) did a study to explore if there were a correlation between preservice teachers' beliefs of personal knowledge of constructivism and personal application of constructivist teaching and learning. The subjects who participated in the research were chosen during the 2000-2001 school year at a public university in the state of Washington. Out of a population of 511 pre-service teachers who completed their student teaching experience, 90 students were chosen by random sampling methodology. The sample included 23 males and 67 females with a mean age of 31. During the 2000 - 2001 academic year, 511 student teachers completed a "Student Attributes" questionnaire administered by their respective university supervisor. The "Student Attributes" form consisted of three questions that addressed constructivism in relation to the students' knowledge and application beliefs. Ninety "Student Attributes" forms were randomly selected for data analysis. The Pearson product-moment correlation was the relational measurement which was used to determine if there were a statistical correlation between constructivist knowledge and application beliefs. The results showed that correlation coefficient for the data between student teachers' beliefs towards constructivist knowledge and application was a high positive relationship of .76 ($r = -.76$). As the student teachers' knowledge of constructivism increased, their belief that they would be "able to apply constructivist principles in the classroom learning situation" tended to increase.

Tsai (2002) conducted a study to explore the relationships among teachers' beliefs about teaching science, learning science and the nature of science. Researcher interviewed with 37 Taiwanese science teachers, teachers' beliefs about teaching, learning and science were respectively categorized as either 'traditional', or 'process', or 'constructivist'. It was found that majority of the science teachers had 'traditional' beliefs. Moreover, more than a half of the teachers had views about teaching, learning and science that were closely aligned.

This study also emphasized ‘nested epistemologies’ which tended to be found in teachers of greater teaching experiences. It was suggested that the ‘nested epistemologies’ affect teachers’ perceptions of the practice of science instruction.

Davies and Rogers (2000) conducted a study which was undertaken with first year primary pre-service teachers at Goldsmiths College, University of London U.K. The purpose of the research was to study the influence of pre-service teachers’ prior educational experience and beliefs about the nature of and relationship between science and technology upon their planning for classroom activities incorporating both areas of curriculum. The researchers found that many students understood the inclusion of a school-based assignment for exploring the relationship between science and D&T in the classroom forced them to consider the nature of the subjects in a new way.

McErgney et al. (1983) described a method that could be used to evaluate teachers’ planning abilities. Preactive Decision Exercises was designed to simulate the types of planning problems that teachers faced in real life. It consisted of five steps: domain definition, item specification, item review before administration, test administration and scoring and item analysis. Content validity and discriminant validity of the tool were assessed. This research was important as it aimed out about the relationship between the competence students acquired in training and their performance as teachers should renewe attention.

2.6.7. Research Studies Related to Constructivism in Turkey

Tatlı (2007) conducted a study to identify preservice teachers’ opinions about constructivist teacher roles. Open-ended questionnaire were applied to 239 pre-service teachers according to their observations in school applications. One way ANOVA was used as a statistical technique for data analysis. The results of the analysis showed that the majority of the primary teachers fulfilled the constructivist principles.

Sağlam (2006) conducted a research study to present suggestions about constructivist based teaching and learning applications in primary schools. This was a descriptive study and both fourth and fifth grade students and their teachers' views were taken about the constructivist learning environments. 1301 individuals from the pilot cities participated in the study. 230 of them were teachers and 1071 of them were students. Poll forms were prepared by the researcher, validity and reliability studies were done. Variance, scheffe and t-test were used for normal distributions and Kruskal-Wallis test was done for abnormal distributions as statistical techniques. The results of the study showed that constructivist based learning environments were more effective according to the aim. In assessment process, students' views changed and the teachers' views did not change.

Savaş (2006) conducted a research study to test the integrated unit and teaching activities based on constructivist approach together and separately during the unit of "Our Close Environment" in social studies class of 4^{th} grades in a state school. The methods and processes were conducted in three experimental groups. 146 fourth graders were the subjects of the study. Pretest-posttest design was used for this research. The research was conducted with four groups, three experimental groups and one control group. The units and activities that were used in experimental and control groups were prepared by the researcher. The instructor was the researcher during the process. Learning Level Test, Attitude Test, Academic Self Confidence Test, Parents' Views Questionnaire, Students' Views Questionnaire and Interviews were the data collection tools of the study. Arithmetic mean, standard deviation, t-test, analysis of variance, scheffe test were used as a statistical technique. Experimental group's academic achievement, attitude and academic self confidence were found as statistically different from the control group after the implementation process. When looking at the students and parents' views, the process in experimental group was perceived in a positive manner.

Şengül (2006) conducted a study to improve success and attitude of sixth grade students. The context was “Flowing Electricity” “Electricity Guiding Our Life” unit. Academic achievement in science, attitude and effects of gender were analyzed in this study. The sampling was constructed with 68 students. Lesson plans were prepared according to experiments and discussion method and applied in the experimental group and traditional approach was applied in the control group. The results of the study show that there was a statistically significant difference between the experimental and the control group’s academic difference and attitude in favor of experimental group.

Salman (2006) organized a research study to evaluate the research studies which were done in Turkey. Documentary Method was used to collect data. The results of the suitability of the constructivist approach were presented according to the biology units and concept teaching. The results showed that there was no statistically significant difference between the traditional approach and constructivist approach and considering the educational environment in Turkey, weak applicability of the studies were the results of the study.

Yılmaz (2006) aimed to find out what level primary classroom teachers could build constructivist learning environments in fifth class Science and Technology lesson and whether the gender and experience variables would affect the constructivist learning environment. The sample of this research study was 104 Science and Technology teachers who were from state schools in İstanbul. The data collection tool of the study was “Constructivist Learning Environment Scale. The cronbach alpha reliability coefficient of the scale was found as 0.87. T-test was used to find the application level of the teachers considering gender. The experiences of the teachers were compared by one way variance analysis. The results showed that the majority of the teachers could build constructivist learning environments and there was no statistically significant effect of gender on organizing constructivist-based learning environments.

Kıdık (2005) conducted a research study to examine the plan of the instructional model on fourth grade primary school students' achievement in "Variation of Living Things" unit. 35 students from two classes participated in the study. Pretest-posttest control group design was used for this study. Achievement test was prepared by the researcher and applied to students as a pretest. After pretest, instruction was applied to the experimental group and the traditional to control group. The instruction was developed as a mind mapping technique. The pretest and posttest scores of achievement test were analyzed by dependent and independent t-test. The achievement mean score of the experimental group was significantly higher than the control group.

Kesal and Aksu (2005) conducted a study to identify the students' perceptions about constructivist learning environment in English Language Teaching (ELT) Methodology II courses and examined if students' perception of the learning environment could be changed according to certain variables. 410 students who were taking ELT Methodology II course were the subjects of the study. The results of the study showed that majority of the students perceived the learning environment as constructivist in nature. The university which the students attended and their expected average score from the course affected their perceptions. Gender and high school background did not affect their perceptions.

Önal (2005) searched the effects of performance based assessment on the science process skills of seventh grade elementary school students in science education in master thesis. For this study, Science Process Skills Test was constructed and implemented 72 students (36 of them experiment, 36 of them control group) before the process. In the experimental group, performance based assessment was implemented and after the process, Science Process Skills Test and Science Attitude Scale were implemented in both group of the students. Mixed methodology was used for this study. Although it could be seen as pretest-posttest control group experimental design, researcher made observations, semi-structured interviews with students and teachers and student portfolios were used as qualitative data. The research results showed that using performance-based assessment had a positive effect on students' scientific process skills, science attitudes and both teachers' and students' perceptions about learning science.

Yurdakul (2004) did a dissertation study to prepare and to implement a hypothetical constructivist curriculum design related to assumptions of constructivist learning theory and assessed the design based on learners' problem solving skills, metacognitive awareness, attitudes towards the course and contributions to the teaching and learning process related to the traditional instructional approach. The mixed research design (both pretest-posttest control group design and qualitative data gathering procedures) was used in this study. The subjects of the study were 69 students from sixth grade classrooms. The implementation process lasted for 10 weeks. The implementation process was prepared according to 5E model and design included cooperative learning, problem-based learning and project based learning in relation with the constructivist learning approach. Qualitative data were gathered from observation field notes, reflective journals of students, teachers' unstructured observation logs and interviews with the participants. Independent sample, paired sample and independent t-test were used for quantitative data analysis; inductive content data analysis technique was used for qualitative data. Quantitative results of the study showed that learners improved their problem solving skills, metacognitive awareness and developed positive attitudes towards the course. The qualitative data identified that the constructivist learning environment was affective on learners' pride, relaxation, feeling safe, self confidence.

Akkuş, Kadayıfçı, Atasoy and Geban (2003) conducted a research study to identify misconceptions related to chemical equilibrium concepts and to investigate the effectiveness of instruction based on the constructivist approach over traditional instruction on 10th grade students from two chemistry classes of the same teacher. Each teaching strategy was randomly assigned to one class. The data were obtained from 32 students in the experimental group who were taught with the instruction informed by the constructivist approach and 39 students in the control group were taught with traditional instruction. The data were analyzed using analysis of covariance. The results showed that the students who used the constructivist instruction gained higher scores than those taught by traditional instruction in terms of achievement related to chemical equilibrium concepts. In the light of the findings which were obtained from the results, an additional misconception of chemical equilibrium concepts was determined in addition to the misconceptions in related literature. This misconception was that when one of the reactants is added to the equilibrium system, the concentration of the substance that was added would decrease below its value at the initial equilibrium.

Akar (2003) did a study on the effects of constructivist learning process on preservice teacher education students' performance, retention, and attitudes in Classroom Management Course. An experimental design and a case study were used together in this study as a mixed methodology. Data were collected through qualitative and quantitative methods. The findings showed that posttest scores were not statistically different between the experimental and the control groups. But significant difference was found in the retention scores in favor of the experimental group. The conceptual change that the learners went through was statistically different in favor of experimental group. Descriptive findings indicated that retention was fostered through constructivist activities that mainly included reflective writing, critical thinking and problem solving. Factors such as active learning, meaningful and enjoyable learning environment, and the attitudes of instructors had a positive impact on student learning. Nevertheless, the load of reflective diary writing and portfolio preparation tasks, and collaborative work could be discouraging and these works had a negative effect on learners' attitudes towards the course.

Uzuntiryaki (2003) conducted a dissertation study with forty-two ninth grade students from two classes of a chemistry course taught by the same teacher in METU Development Foundation Private School in 2000-2001 spring semester. The classes were randomly assigned as the control and the experimental groups. Students in the control group were instructed by traditionally designed chemistry instruction and the students in the experimental group were taught by the instruction based on constructivist approach. Chemical Bonding Concept Test was administered to both groups as a pretest and posttest to identify their understanding of concepts related to chemical bonding. Attitude Scale toward Chemistry as a School Subject was given to the students at the beginning and at the end of the study to determine their attitudes and Science Process Skill Test was given at the beginning of the study to measure their science process skills. Analysis of covariance (ANCOVA) and two-way analysis of variance (ANOVA) were used as a statistical technique to test the hypotheses. The results showed that constructivist instruction had provided significantly better scores about students' achievement related to scientific conceptions about chemical bonding and attitudes toward chemistry as a school subject than the traditionally designed chemistry instruction. Also, there was no significant effect of gender difference on understanding the concepts about chemical bonding and students' attitudes toward chemistry as a school subject.

Şimşek and Yıldırım (2000) examined the administrative and organizational practices in a selected group of secondary vocational schools in Turkey from the point of view of school administrators, teachers and industrial managers. The data used in this research were derived from a large project which had the aim of critically evaluating the Turkish vocational education system on a number of different levels. Observations, semi-structured interviews, documents were used for data collection. The results showed that the Turkish vocational education system was characterized by a centralized, top down bureaucracy, which inhibited innovative capacity. They suggested that systematic professional development of teachers and degree of decentralization were necessary at various levels of the system.

2.6.8. Summary

The review of the literature can be summarized as follows;

1. Research studies about constructivism and science education reveal that practices which cover constructivist approach and its implications are very helpful to develop

students' both cognitive and affective domain. Science achievement and students' attitudes towards science change positively after constructivist-based instruction. Students also learn how to learn after the application of constructivism (Connoly & Beqq, 2006; McKeown, 2003; Uzuntiryaki, 2003; Yurdakul, 2004).

2. Research studies on constructivism and science teacher education show that whatever the level is, using constructivist approach in classroom environments is not an easy process. Researchers agree that more studies should be conducted in both preservice and inservice teacher education. Teachers should know all of the instructional strategies to apply constructivism effectively (Akar, 2003; Akcay, 2007).

3. Research studies' results about using constructivist instruction in science education indicate that both process and product based assessment methodologies should be used in teaching and learning process properly. The properties of all assessment procedures should be known and the types of assessment methodologies should be selected according to the instructional methodology by the teachers in classrooms (Cowie, 2005; Gott & Dugan, 2002; Önal, 2005; Roberts & Gott, 2004).

4. Research studies about scientific literacy and constructivism show that constructivist instructional strategies helped to improve students' scientific literacy abilities. The curricula and classroom environments should be organized by identifying scientific literacy and its required skills (Kim, 2005; Shive, 2005).

5. Research studies about scientific process skills and constructivism reveal that constructivist instructional strategies are the better ways to develop students' scientific process skills. When thinking about scientific process skills are the touchstone of science education, constructivism is the most appropriate approach to science education and scientific process skills (Harlen, 1999; Önal, 2005; Scherz et al., 2005).

6. Research studies about teacher thinking, teacher decision making, teacher planning processes and constructivism indicate that there is a strong relationship between

thinking, decision making processes and teacher planning abilities. For instance, if the teacher does not think according to constructivism, she/he cannot organize classroom environment although she/he knows the principles of constructivist approach. Results show that the number of studies about teacher belief and decision making process should be increased to provide valid suggestion about using constructivism in classroom environments (Plourde & Alawiye, 2003; Sercoussi, 2005; Şimşek & Yıldırım, 2000; Tsai, 2002).

7. The research studies from the different areas in world and in Turkey show that constructivist-based instructional strategies are effective to help students to gain scientific literacy abilities which consist of scientific process skills, learning science concepts and attitudes toward science, metacognitive and problem solving abilities of children (Akar, 2003; Chin-Chung Tsai, 2000; Goodnough, 2005; Hudson, 2004; Savaş, 2006; Schertz et al., 2005; Tytler, 2002; Uzuntiryaki, 2003; Yurdakul, 2004). In preservice teacher education level, preservice teachers' expected scores of the course affected the perceptions of students about constructivist learning environments (Kesal & Aksu, 2005) and there is a strong correlation between preservice teachers beliefs about constructivist based learning environment and their applications (Plourde & Alawiye, 2003; Osman & Lee, A., 2003). Therefore, in-service and pre-service teacher training is very important for using these instructional methodologies and authentic assessment techniques effectively. Using mixed methodologies (both qualitative and quantitative) useful to obtain valuable results and to have effective interpretation. Teachers' and students' perceptions are positive towards effective concept teaching and eclectic philosophy of constructivism (Akar, 2003; Akcay, 2007; Uzuntiryaki, 2003).

CHAPTER III

METHOD

The purpose of this research study was to examine the impact of using constructivist-based instruction on the fourth grade preservice science teachers' achievement, attitudes towards science teaching, and scientific process skills in Science Teaching Methods II course. This chapter explains the methodology of the study covering the overall research design, research questions, hypotheses, variables of the study, general description of the treatment, context, characteristics of the participants, data collection instruments, data collection procedures, treatment verification, data analysis, assumptions, limitations and power analysis of the study.

3.1. Overall Research Design of the Study

Quasi-experimental research design was used in order to investigate the impact of the constructivist-based instruction on the fourth grade preservice science teachers' achievement, attitudes towards science teaching, and scientific process skills in Science Teaching Methods II course in this study. Since random assignment of subjects to the experimental and control groups was not possible quasi experimental research design was used in this research study.

In most of the research studies dealing with constructivist-based instruction in both elementary and pre-service education level in the literature, random sampling was not possible due to several factors such the rules, school conditions or time schedule of courses. As such, quasi experimental designs are used when the researcher analyzes the effect of independent variable on one or more dependent variables (Fraenkel & Wallen, 2000).

The constructivist-based instruction implemented in the experimental group was defined as the independent variable; achievement, attitudes towards science teaching and scientific process skills were defined as the dependent variables of the study.

Constructivist-based instruction including student-centered activities were used in the experimental group of the study, while traditional instruction was used in the control group during this research study.

This research study was conducted in Hacettepe University, Faculty of Education, Department of Science Education. The preservice science teachers who had taken Science Teaching Methods II course before, and will take this course in the future at Faculty of Education Science Education Departments in Turkey were identified as the theoretical population of this study. All fourth grade preservice science teachers who took Science Teaching Methods II course at Hacettepe University (N=103) were the participants of the study. This study was conducted throughout the fall semester of the 2007-2008 academic year.

At the beginning of the fall semester, all the participants were divided into two groups by the department. One of the classes was named "01" section with 50 students and the other class was named "02" section with 53 students. The course instructor was the same for both of the two sections.

The equality of two groups defined above was controlled by comparing the pretest scores of Achievement Test (PREAT), Science Process Skills Test (PRESPST) and Attitude towards Science Teaching Scale (PREATSTS).

This research study lasted for 15 weeks. Fall semester in Hacettepe University begins in the third week of September 2007 and continues till the fourth week of January 2008. 15 weeks and 4 lesson hours in a week in total were devoted the Science Teaching Methods II course. The content of the course was divided into two, namely theoretical and application parts. These parts were organized according to the description of the course and instructor's outline. All the fourth grade students were taught the same concepts of science teaching according to the course outline and during the same amount of time. The participants in both experimental and control groups did not know about the treatment process. This was controlled by the researcher and the instructor of the course. Considering the ethical issues related to the academic development of students, after the retention tests, the documents which were used by the experiment group were shared with the control group by the researcher. The content was not changed for the two groups. The main difference between the two groups was that interactive, student-centered, group activities were carried out during the theoretical part of the course; group evaluation, self evaluation and presentation observation forms were used for the practical part of the course in the experimental group and lecture based sessions were organized without interactive instruction tools in the control group.

Theoretical part of the course was carried out in seven units: “General Philosophy and Properties of Science and Technology Curriculum”, “Problem-Based Learning in Science Education”, “Project-Based Learning in Science Education”, “Creating Indoor Activities in Science Education”, “Creating Outdoor Activities in Science Education”, “Teaching Concepts in Science Education”, and “Creative Drama Applications in Science Education”. At the beginning of these units, general introduction and presentation of course outline were provided to the preservice science teachers. At the beginning of the course, pretests of Achievement (PREAT), Science Process Skill (PRESPST) and Attitude towards Science Teaching Scale (PREATSTS) were applied to both the experimental and the control groups and the participants in the groups were compared regarding these three scores for providing equivalence. After the whole process, post tests of Achievement (POSTAT), Science Process Skill Test (POSTSPST) and Attitude towards Science Teaching Scale (POSTATSTS) were also administered to both the experimental and the control groups.

Ten weeks after the completion of the treatment, retention tests of Achievement (RAT), Science Process Skills (RSPST) and Attitude towards Science Teaching (RATSTS) were applied to both the experimental and the control groups in order to assess the retained scores of achievement, scientific process skills and attitude towards science teaching.

During and after the implementation process, formative focus group interviews in both the experimental and the control groups were conducted by the researcher. The participants of the focus groups were selected purposefully according to the participants' responses to the attitude scale and tests.

The questionnaire which consisted of open-ended questions and was given to both experimental and control group participants before and after the implementation process to identify their perceptions about Science Teaching Methods II and general science teaching principles. Since answering the questions was on voluntary basis, 80 of the 103 students answered the questionnaire. Questionnaire was administered to all the groups during and after the implementation. Semi-structured interviews were held with 2 focus groups (2x3, N=12) in both the experimental and the control groups. Semi-structured interviews were conducted during the implementation and after the implementation. Semi-structured interview participants were selected purposefully. The interview participants were selected according to the scores of achievement, attitude scale and scientific process skills. One of the focus groups was selected from the high achievers (those who had the highest test grades) in both the experimental and the control groups. The other one was selected from the slow learners (those who had the lowest grades) in both the experimental and the control groups. Summative semi-structured interviews were also conducted after the treatment with 2 focus groups with 12 interviewees.

Table 3.1 shows the overall research design with time schedule which was used throughout this study. Especially the tools which were used in this study were provided according to groups and time.

Table 3.1

Representation of the research design of the study

Groups	Pre-Treatment 17-21 September 2007	During the Treatment 26 September 2007-24 January 2008	Post-treatment 31 January 2008	10 Weeks after the treatment 3 April 2008
Experimental Group	*Scientific Process Skills Test *Attitude towards Science Teaching Scale *Achievement Test *Questionnaire	* Formative Focus Group Interviews	*Scientific Process Skill Test *Attitude towards Science Teaching Scale * Achievement Test *Questionnaire *Summative Focus Group Interviews	*Scientific Process Skill Test *Attitude Towards Science Teaching Scale * Achievement Test
Control Group	*Scientific Process Skill Test *Attitude Towards Science Teaching Scale * Achievement Test *Questionnaire	* Formative Focus Group Interviews	*Scientific Process Skill Test *Attitude towards Science Teaching Scale * Achievement Test *Questionnaire *Summative Focus Group Interviews	*Scientific Process Skill Test *Attitude Towards Science Teaching Scale * Achievement Test

3.2. Research Questions

The purpose of this study was to investigate the effects of constructivist-based instruction on the fourth grade preservice science teachers' immediate and retained achievement, science process skills and attitudes towards science teaching.

This study aimed to answer the following research questions;

1. Is there a significant difference between the immediate and retained achievement test scores of the preservice science teachers who were exposed to constructivist instruction and those who were exposed to traditional instruction?

2. Is there a significant difference between the immediate and retained attitude towards science teaching scale scores of the preservice science teachers who were exposed to constructivist instruction and those who were exposed to traditional instruction?

3. Is there a significant difference between the immediate and retained science process skills test scores of the preservice science teachers who were exposed to constructivist instruction and those who were exposed to traditional instruction?

4. What are the perceptions of the preservice science teachers about science teaching and constructivism who were exposed to constructivist instruction and those who were exposed to traditional instruction both during and after the implementation process?

3.3. Hypotheses

The research questions stated above were tested with the following hypotheses that are stated in null form.

Null Hypothesis 1.1. There is no significant difference between the immediate achievement test scores of the preservice science teachers who were exposed to constructivist instruction and those who were exposed to traditional instruction.

Null Hypothesis 1.2. There is no significant difference between the retained achievement test of the preservice science teachers who were exposed to constructivist instruction and those who were exposed to traditional instruction.

Null Hypothesis 2.1. There is no significant difference between the immediate attitude towards science teaching scale scores of the preservice science teachers who were exposed to constructivist instruction and those who were exposed to traditional instruction.

Null Hypothesis 2.2. There is no significant difference between the retained attitude towards science teaching scale scores of the preservice science teachers who were exposed to constructivist instruction and those who were exposed to traditional instruction.

Null Hypothesis 3.1. There is no significant difference between the immediate science process skills test scores of the preservice science teachers who were exposed to constructivist instruction and those who were exposed to traditional instruction.

Null Hypothesis 3.2. There is no significant difference between the retained science process skills test scores of the preservice science teachers who were exposed to constructivist instruction and those who were exposed to traditional instruction.

3.4. Description of Variables

Four variables were used in this research study. One of them is independent variable and three of them are dependent variables. Variables of the study were given below;

Independent Variable: Treatment (Instructional Method): Constructivist Instruction According to Yager's (1991) Constructivist Learning Model in the experimental group and traditional instruction in the control group.

Dependent Variables: (a) immediate and retained achievement, (b) immediate and retained attitude towards Science Teaching (c) immediate and retained science process skills.

3.5. Constructivist Instruction according to Yager's (1991) Constructivist Learning Model

All of the activities in the experimental group were prepared by using the constructivist approach. The strategy was based on Yager's (1991) constructivist learning model. According to this strategy, the first step is called as *invitation*. The teacher asked the students some questions at the beginning of the instruction in order to activate students' prior knowledge and promote student-student interaction and agreement before presenting the concept. For example, the teacher started to lecture with a question asking what is meant by a scientific literacy or constructivism in science education. The second step is called *exploration*. In this step, students were allowed to discuss the question in groups by using their previous knowledge related to learning and teaching approaches, strategies and techniques. The teacher created groups by assigning numbers to each student and then same numbers came together and to form a group. The members of the groups changed each time and learners have the opportunity to meet different people. Each group consisted of approximately five students. They shared different ideas, were respectful of all ideas and integrated different ideas in a view. They created different outcomes. Researcher did not interfere with students' discussions. The third step was called as *proposing explanations and solutions*. The groups expressed their own ideas, provided their own reasons in this step and the teacher integrated all the ideas according to the course aims. The fourth and the last step was called as *taking actions*. Students brainstormed and discussed how they could relate and transfer their learnings into the daily life situations and make use of them. These steps were explained according to the content in constructivist-based lesson plans during the implementation process.

3.6. The Context

There are thirty three universities who have Faculties of Education and Departments of Science Education. Hacettepe University Science Education Department is the third successful in terms of the 2007 University Entrance Examination (ÖSS) scores of students. It is the sixteenth most successful department in 2007 Public Personnel Selection Examination (KPSS) in the Educational Sciences test among the 33 universities.

Science Teaching Methods II course is offered to preservice science education students in the fourth year of the Curricula of Science Teacher Education in Faculties of Education. This course is compulsory for all Science Education students. Before attending this course, preservice science teachers enroll in introductory pedagogical courses which are called Introduction to Teaching Profession, School Experience I in the first year; Psychology of Learning, Planning and Assessing Instruction in the second year; Classroom Management and Science Teaching Methods of Science in third year. Science Teaching Methods I (STM I) course is the prerequisite course for Science Teaching Methods II (STM II). In STM I, students learn the basic concepts of science education in terms of theoretical knowledge but detail. Relating the theoretical background to the practical part is expected during the Science Teaching Methods II (STM II) course.

Science Teaching Methods II (STM II) course covers both the theoretical and practical parts of science teaching. STM II course is offered for four hours per week throughout a semester. There is no identified textbook which is followed in the course. Instructor uses different kinds of sources in the class. According to Higher Education Council's course description; the course consists of the following areas: 1) Introduction to Nature of Science and Science Teaching, 2) Understanding the Science and Technology Curriculum 3) Problem Based Learning and its Applications to Science Education, 4) Project Based Learning and Its Applications to Science Education 5) Teaching Concepts and General Misconceptions in Science Education, Constructing Concept Cartoons and Conceptual Change Texts 6) Creating a lesson and activity plan in Science Education 7) Multiple Intelligences and Constructivism in Science Education, 8) Measurement and Evaluation in Science Education 9) Preparation of Unit and Daily Plans From Selected Units in Science and Technology

Curriculum. The course objectives which were obtained from the instructor's outlines and Higher Education Council definitions were provided in Table 3.2.

Table 3.2

Science teaching methods II course objectives

Learners are expected to
1. Understand general characteristics and fundamental concepts of Science and Technology Curriculum
2. Comprehend different teaching and learning approaches, methodologies and techniques which are effective in science education
3. Develop and apply effective learning environments in science education.
4. Improve awareness of the effect of social interaction and group working for teaching and learning science.
5. Create documents about teaching, learning, measurement and evaluation process of science education.

3.7. Constructivist Lesson Plans

Lesson plans (See Appendix P) were prepared according to the constructivist approach by using different student-centered teaching and learning approaches, strategies and techniques by the researcher. Two experts from science education (one of them is the instructor of the course and the other one is from curriculum and instruction field) investigated the lesson plans according to Constructivist Learning Environment Criteria and the questions (See Appendix R) which were prepared by the researcher. Constructivist based lesson plans were piloted with approximately 50 second grade preservice science teachers who were from Hacettepe University Faculty of Education Department of Science Education during the Planning and Assessing the Instruction course. Achievement tests were applied to the pilot group both before and after the piloting process. Achievement test results and expert views were used to provide treatment verification of this study. Science process skills test and achievement test related to the course were administered to the second grade preservice teachers both before and after the implementation. Results of the posttests of science process skills and achievement showed that preservice teachers become more successful after the implementation.Researcher reorganized the activities and procedures according to the results of the pilot study and experts' views. The language of the activities were corrected firstly. Secondly affective outcomes 4.2 and 4.3 were added, performance outcome 5.5 was added and measurement and evaluation questions related to second level were modified in the plans.

3.8. Participants

3.8.1. Quasi-Experimental Research Participants

The subjects of the study were (N=103) fourth grade preservice science teachers from Hacettepe University, Faculty of Education Department of Science Education. 103 preservice science teachers were divided into two groups. One of them is called 01 section and consisted of 53 preservice science teachers. The other one is called 02 section and consisted of 50 preservice science teachers. Only the groups were randomly assigned as the experimental and the control. The equalivance of the groups were controlled by using independent sample t-test for comparing the pre scores of achievement test (PRECAT), scientific process skills test (PRESPST) and the attitude towards science teaching scale (PREATSTS). General distribution of the subjects of the study was shown in Table 3.3.

Table 3.3

Subjects of the study

Gender	Experimental Group	Control Group	Total
Male	21	19	40
Female	32	31	63
Total	53	50	103

3.8.2. Questionnaire and Semi Structured Focus Group Participants

Questionnaire was distributed the whole participants in both experimental and control groups. Although 103 participants were taken the questionnaire, 80 of them were returned back and analyzed by the researcher. Questionnaire were given to participants in both before and after the implementation process. Semi-structured focus group interview participants were selected purposefully by looking at both experimental and control group participants' scores in Achievement Test, Science Process Skills Test and Attitude Towards Science Teaching Scale and responses towards questionnaire. The highest achievers (three of them from experimental and three of them from control group) and the slowest learners (three of them from experimental and three of them from control group), totally 12 participants (six of them from experimental and six of them from control group) were selected purposefully for both formative and summative focus group interviews.

3.9. Data Collection Instruments

The following measurement and evaluation instruments were used to find answers to the research questions, to test the hypotheses and to use during the implementation process as instructional tools;

- Achievement Tests: Pre-test (PREAT), Post-test (POSTAT) and retention test (RAT)
- Attitude towards Science Teaching Scale: Pre-test (PREATSTS), post-test (POSTATSTS) and retention test (RATSTS)
- Science Process Skills Test: Pre-test (PRESPST), post-test (POSTSPST) and retention test (RSPST)
- Questionnaire (Used in both experimental and control group during and after the implementation process)
- Semi-Structured Interview Questions (Used in both experimental and control group during and after the implementation process)

3.9.1. Achievement Test

Achievement Test (See Appendix E) which consisted of 10 open-ended questions was prepared by the researcher before the implementation process. This test was piloted with 70 graduates of Hacettepe University Faculty of Education Department of Science Education who took Science Teaching Methods II (STM-II) course last year.

Graded scoring key (rubrics) (See Appendix G) was created for this test by the researcher. To provide evidence for content validity, two expert views were taken for the test and rubrics. One of them is from science education field who is the instructor of the course. She has master's and PhD degrees from measurement and evaluation and she is a professor in science education. The other is from curriculum and instruction field and has her master's and PhD degrees from curriculum and instruction department and she is an assistant professor in a university. After the completion of the pre-test and posttests, the researcher and one expert from the science education field graded the test taking rubrics into consideration. Correlation coefficient was calculated between the researcher scores and expert's scores. The correlation coefficient was calculated as 0. 78 first time for piloting. After grading 30 papers in total, the last and acceptable correlation coefficient was found as 0.9. The test covers the following: The topics of key concepts of constructivism, principles of constructivist learning environment, teacher and student characteristics, principles of constructivist measurement and evaluation strategies and their areas of use, the main characteristics of problem-based learning, the key points which should be considered as a problem-based scenario, properties of measurement and evaluation techniques which are used during project-based learning process, the main steps which should be followed during the preparation of indoor activities, the key points which should be considered during the preparation of outdoor activities, the relationship between creative drama and science education, examples in application of creative drama in science education, the main properties of active effective concept learning, the strategies of effective concept learning, the importance of outdoor activities in science education, planning interesting indoor activities in science and the process which the science process skills are gained by the students in science classes.

According to the Table of Specification of the Achievement Test (See Appendix F), two experts (one is the instructor of the course and the other one is from curriculum and instruction field) views were taken to provide evidence for content validity. Some parallel questions were reorganized (Questions 1 and 10 were changed), the questions about measurement and evaluation process were added and the language of the test was corrected according to the experts' views.

3.9.2. Attitude Towards Science Teaching Scale

This scale (See Appendix D) consists of 11 positive statements and 10 negative statements and was developed by Thomson and Shrigley in 1986. This is a five-point likert scale. The scale was adapted to Turkish by Özkan, Tekkaya and Çakıroğlu (2002). The cronbach alpha reliability coefficient of the scale is 0.83. The statements of the scale cover the preparation, application, measurement and evaluation, relationship between the other subjects of science teaching. This scale was piloted with 220 preservice teachers for this study with the first, second and third year students of Hacettepe University Faculty of Education Department of Science Education and the third year students of Middle East Technical University Faculty of Science Education in the first week of fall semester 2007-2008 academic year. The reliability coefficient of the scale was found as 0.862. The cronbach alpha reliability coefficient of the sample of this research study was found as 0.882.

3.9.3. Science Process Skills Test

This test (See Appendix A) was constructed by the researcher during the master thesis and consists of 36 items related to general science concepts. Questions were developed by analyzing the knowledge and skill taxonomy of TIMSS (Third International Mathematics and Science Study) PISA (Programme for International Student Assessment) questions. All the questions are skill oriented and aimed to measure the scientific process skills as defined by TIMSS, 2003. The structures of the TIMSS and PISA questions were identified and adapted to the researcher's questions. The items of the Science Process Skills Test are skill-based. The cronbach alpha reliability coefficient of this test was calculated as 0.89 in the researcher's master thesis (Önal, 2005). The pilot study was conducted with 363 students who were in the first, second and third years at Hacettepe University Faculty of Education Department of Science Education; the second and the third years at Middle East Technical University Faculty of Education Department of Science Education at the beginning of 2007-2008 fall semester for this study. The cronbach alpha reliability coefficient of the test in the pilot study in the current research was found as 0.92. The cronbach alpha reliability coefficient of the test was calculated for this study and found as 0.9.

This test consists of two major skill parts. These are conceptual understanding and reasoning and analysis. Taxonomical levels of TIMSS 2003 (See Appendix B) were used in Science Process Skills Test. There are three major taxonomical levels in TIMSS 2003.

Science Process Skills Test's taxonomy was constructed by taking some of the levels from Taxonomy of TIMSS according to the expert views from measurement and evaluation field. Then, factor analysis was done to provide evidence for construct validity. Factor analysis and item analysis of this test were reported in literature and items of the test were collected in meaningful levels. The taxonomy for Science Process Skills Test related to the items are summarized in Appendix C. This test was used in this research study considering the all factor levels holistically. This test consists of the questions related to science topics which are light and voice, force and movement, the structure of matter, electricity, natural processes, heat, body systems, solar system, the structure of earth. These topics were presented during eighth to fifteenth week of the implementation process by the participants in both experimental and control groups.

3.9.4. Questionnaire

The questionnaire (See Appendix L) consisted of seven open-ended questions which cover the reflections of the students on science teaching before and after the implementation process of the course. It was used to identify which approaches, methods and techniques the participants preferred to use in science teaching, description of a successful science teacher, the areas of strength and the areas of weakness which could be improved for Science Teaching Methods II course, the skills which were gained after the course and the expectations about the course. These questions had alternative clues. This instrument was prepared by the researcher. The questionnaire was applied to the experimental and to the control groups as pretests and posttests both before and after the treatment process. The questions of 3 and 6 were added to form according to experts' views. The open-ended questionnaire was applied to 5 people in total who graduated from Hacettepe University Faculty of Education Department of Science Education for the pilot study. Two expert views were taken to provide content validity. Of the103 participants, 80 provided valuable answers to the questionnaire and 80 of the open ended questionnaire results were analyzed.

3.9.5. Semi-Structured Interview Questions

The semi-structured interview questions were developed from the open-ended questionnaire. These were the same questions, but during the interview, different questions arose due to the ongoing process of the interviews. The reasons of failure of the teachers in the field, the things that can be done to increase the quality of instruction in teacher education courses were added to the semi-structure interview questions. The formative and summative semi-structured interviews (See Appendix M & Appendix N) were conducted during and after the process with the preservice science teachers from both the experimental and the control groups. Semi-structure interview questions were applied to 5 people in total who graduated from Hacettepe University Faculty of Education Department of Science Education as a pilot study. The items which could not be understood were revised and the formative interview questions of 1 was changed and question 4 was added. Two expert views were taken for providing content validity. The format and the language of the questions were reorganized according to the pilot study, preservice science teachers' and experts' views.

3.10. Data Collection Procedures

After official permissions were taken; the pre-tests (Science Process Skill Test, Achievement Test and Attitude towards Science Teaching Scale) were conducted to both the experimental and the control groups. From the beginning to the end of the process, constructivist based instruction was used in the experimental group. The activities and tasks during the process were mainly based on the Yager's (1991) Constructivist Learning Model.

The researcher was the instructor of both the experimental and the control groups in the study. The instructor of the course was an observer in the study. The researcher and the instructor attended both the experimental and the control groups for 15 weeks. For about five weeks, two observers (one is the instructor of the course and the other one is a research assistant from different university in science education) observed the applications in both the experimental and the control groups. The purpose of working with an instructor and having an observer was to minimize the internal threat to overcome the researcher bias in the study. The same content was taught in the control group. The difference between the two groups was that critical and reflective thinking questions, group activities, self and group directed assessment activities were carried out in the experimental group, but not in the control group. Although the course included the same content, the control group had teacher- directed instruction and most of the activities were carried out individually by the participants in the implementation process. While the instruction was teacher-centered in the control group, the instructor was a guide and facilitator in the experimental group. Researcher had the responsibility of identifying and using prior knowledge of students in the experimental group. In the control group, the researcher lectured the content and objectives directly to the students, and there was not so much interaction between the students and the teacher.

The instructor used the same presentation documents in both groups. But before transferring knowledge to the students, the instructor planned some group activities considering students' previous knowledge and the skills about the topic in the experimental group. Presentation observation form, self assessment and group assessment form results were given in Appendix 11 to provide treatment verification of the study.The comparison of the experimental and control group learning activities was provided in Table 3.4.

Table 3.4

Comparison of the experimental and control group teaching and learning process

	Experimental	**Control**
The Role of the Instructor	Learner, facilitator, scaffolder and guide	Director,leader,expert
The Role of the Learners	They explore, solve problems, investigate, inquire, reflect, discuss, work in pairs	Work individually,only do what the instructor tells.
Learning Environment	Reflective, learner-centered, collaborative, constructivist	Traditional, teacher centered.
Measurement and Evaluation	Process-based (Portfolio assessment, performance based assessment, peer and self evaluation	Especially summative, based on paper-pencil goal directed measurements.

According to the implementation process, during the first eight weeks, the contents related to science education were provided to the experimental group with student-centered approaches, strategies and techniques. Researcher was learner, facilitator, scaffolder and guide during the process. After eight weeks, the participants in the experimental group started to present their own lesson plans according to constructivist teaching and learning strategies and make their presentations. Teaching and learning environment was interactive during the implementation process in experimental group. Participants in experimental group prepared their own criteria about their presentations before the presentation process started. The researcher analyzed all of their criteria and prepared a rubric (graded scoring key) according to participants' views and provided it for the participants during the presentation process. Both the experimental and the control groups' participants worked in groups during the presentation preparation process. The presenters in the experimental group were assessed by the other groups, the instructor and themselves with the help of "Group

Assessment Form", "Presentation Observation Form" and "Self Assessment Form". Periodical feedback was provided for the participants in the experimental group but these forms and feedback were not provided for the control group participants. The content was the same for control group during the whole process. Teaching and learning environment in control group was traditional and teacher centered. Researcher was a director and a presenter during first eight weeks. After eight weeks, participants started to present their preparations about the science topics Researcher was a listener at that time and did not interfere anything about the presentations and did not give any feedback. Researcher assessed participants' performances by commonsense not objective and non written criteria. The control group participants were not involved in graded scoring key (rubrics) preparation process for presentations. Self assessment, group assessment and presentation observation forms were explained below.

3.10.1. Group Assessment Form

This form (See Appendix I) consists of 17 items measuring the preservice science teachers' perceptions of themselves and their friends in the group studies. Two expert views were (one is from the curriculum and instruction field and the other one is from the science education field) taken to provide content validity of the forms. Science education field expert is the instructor of the course. She has a master's and PhD degree from measurement and evaluation and she is a professor in science education. Curriculum and instruction field expert has her master's and PhD degrees from curriculum and instruction department and she is an assistant professor in a university. The form was applied to 15 people who graduated from the Hacettepe University Faculty of Education Department of Science Education and 168 preservice teachers. In total 183 people from Hacettepe University participated in pilot study. The reliability coefficient of this test was calculated as 0.91. Items 8, 14 and 16 were added to the form. The structures of items 2 and 9 were changed. The content and the language of the form were revised according to experts' views and the results of the pilot study.

3.10.2. Self Assessment Form

This form (See Appendix J) consists of 14 items measuring the preservice science teachers' perceptions of themselves in group studies and general study process of this course. Two expert views were (one is from the curriculum and instruction field, and the other one is from the science education field) taken to provide content validity of the forms. Science education field expert was the instructor of the course. She has master's and PhD degree from measurement and evaluation and she is a professor in science education. Curriculum and instruction field expert had her master's and PhD degree from curriculum and instruction department and she is an assistant professor in a university. The forms were applied to 15 people who graduated from the Hacettepe University Faculty of Education Department of Science Education and 132 preservice teachers. In total, 147 people from Hacettepe University participated in the pilot study. The reliability coefficient of this form was calculated as 0.86. Items of 2 and 11 were added to the form. The structures of the items of 7, 10 and 13 were changed. Also the content and the language of the whole form were revised according to experts' views and the results of the pilot study.

3.10.3. Presentation Observation Form

This form covers the general teaching and learning environment, preparation, implication, measurement and evaluation processes and in what level the presentations are constructivist. Presentation observation form (See Appendix I) was used by the students who observed the presenters in the experimental group, the instructor who listened to the presentation group and the researcher in both the experimental and the control groups. Two expert views were (one is from the curriculum and instruction field and the other one is from the science education field) taken to provide content validity of the forms. Science education field expert is the instructor of the course. She has master's and PhD degrees from measurement and evaluation and she is a professor in science education. Curriculum and instruction field expert has her master's and PhD degrees from curriculum and instruction department and she is an assistant professor at a university. Forms were applied to 15 people who graduated from the Hacettepe University Faculty of Education Department of Science Education and 50 preservice science teachers. In total 65 people participated in pilot study. According to the expert views and the results of the pilot study, the content of the form was extended (For example, general description of the class, introductory activities and last two statements were added), tables were organized and the language of the statements was corrected according to the experts' views. Presentation observation form of the results were provided below to provide treatment verification of the study.

The evidence for treatment verification was provided by the observation presentation forms. The analysis of the presentation observation form according to the observers in this study was provided in Appendix K. The whole process regarding the experimental group was summarized in Table 3.5.

Table 3.5

General teaching and learning process in the experimental group

Weeks	Topics	Approaches, Strategies and Techniques Used	Materials Used	Expected Student Skills
Week I	Introducing learning environments	Dialogue collaboration, research, peer teaching, peer evaluation, project and problem based tasks	Reflective student papers, group work reports	Critical thinking, reflective thinking, observation, analysis, synthesis
Week II	General philosophy and properties of science and technology curriculum	Problem-based learning, role playing, question-answer, inquiry-based learning, creative drama and writing in a role technique.	Reflective student diaries, group work reports	Critical thinking, reflective thinking, observation, analysis, synthesis, integrating into daily life situations.
Week III	Problem Based Learning In Science Education	Problem based learning approach and question-answer technique.	Problem-based learning scenarios and group work reports	Critical thinking, reflective thinking, observation, analysis, synthesis, integrating into daily life situations.

Table 3.5 Continued

Week IV	Project Based Learning Approach In Science Education	Project based learning approach, inquiry based learning approach and question-answer method.	Reflective student diaries, group work reports	Communication,analysis,synthesis Critical thinking, integrating into daily life situations.
Week V	Creating Indoor Activities In Science Education	Creative drama, inquiry-based learning and cooperative learning	Creative drama activity reports, Reflective student diaries	Communication,analysis,synthesis Critical thinking, integrating into daily life situations.
Week VI	Creating Outdoor Activities In Science Education	Creative drama, inquiry-based learning and cooperative learning	Creative drama activity reports, Reflective student diaries	Communication,analysis,synthesis Critical thinking, integrating into daily life situations.
Week VII	Teaching Concepts In Science Education	Question-answer, cooperative learning and six hats technique	Student idea reports, reflective student diaries	Critical thinking, reflective thinking, observation, analysis, synthesis, integrating into daily life situations.
Week VIII	Creative Drama Applications in Science Education	Creative drama, brain storming, question-answer and working by group	Creative drama activity reports, Reflective student diaries	Communication,analysis,synthesis Critical thinking, integrating into daily life situations.
Week IX	Group Presentations I.Reproduction, Growing and Development Processes of Living Things II. Light and Voice	Different constructivist teaching and learning strategies	Group Evaluation Form, Presentation Evaluation Form,Self Evaluation Form Student Criteria	Applying constructivist teaching and learning strategies in science education, critical thinking, reflective thinking, observation, analysis, synthesis, integrating into daily life situations.
Week X	Group Presentations III. Force and Movement IV.The Structure of Matter	Different constructivist teaching and learning strategies	Group Evaluation Form, Presentation Evaluation Form,Self Evaluation Form Participants' Criteria	Applying constructivist teaching and learning strategies in science education, critical thinking, reflective thinking, observation, analysis, synthesis, integrating into daily life situations.

Table 3.5 Continued

Week XI	Group Presentations V.Systems in Our Body VI. What Elements Does the Earth Consist of?	Different constructivist teaching and learning strategies	Group Evaluation Form, Presentation Evaluation Form,Self Evaluation Form Participants' Criteria	Applying constructivist teaching and learning strategies in science education, critical thinking, reflective thinking, observation, analysis, synthesis, integrating into daily life situations.
Week XII	Group Presentations VII. Solar System and Space VII. The Properties of Matter	Different constructivist teaching and learning strategies	Group Evaluation Form, Presentation Evaluation Form,Self Evaluation Form Participants' Criteria	Applying constructivist teaching and learning strategies in science education, critical thinking, reflective thinking, observation, analysis, synthesis, integrating into daily life situations.
Week XIII	Group Presentations IX. Electricity in Our Lives X. The Relationship between Living Things and Energy	Different constructivist teaching and learning strategies	Group Evaluation Form, Presentation Evaluation Form,Self Evaluation Form Participants' Criteria	Applying constructivist teaching and learning strategies in science education, critical thinking, reflective thinking, observation, analysis, synthesis, integrating into daily life situations.
Week XIV	Group Presentations XI. Natural Processes (Circles of Water, Air and Soil) XII. Division of Cell and Heredity	Different constructivist teaching and learning strategies	Group Evaluation Form, Presentation Evaluation Form,Self Evaluation Form Participants' Criteria	Applying constructivist teaching and learning strategies in science education, critical thinking, reflective thinking, observation, analysis, synthesis, integrating into daily life situations.
Week XV	XIII. States of Matter and Heat	Different constructivist teaching and learning strategies	Group Evaluation Form, Presentation Evaluation Form,Self Evaluation Form Participants' Criteria	Applying constructivist teaching and learning strategies in science education, critical thinking, reflective thinking, observation, analysis, synthesis, integrating into daily life situations.

Implementation process of the control group was explained according to traditional approach. The whole implementation process in control group was summarized in Table 3.6.

Table 3.6
General teaching and learning process in the control group

Weeks	Topics	Approaches, Strategies and Techniques Used	Materials Used	Expected Student Skills
Week I	Introducing learning environments	Presentation, lecturing, question-answer	Power point presentation and course notes	Understanding the concept and giving some examples related to this
Week II	General philosophy and properties of science and technology curriculum	Presentation, lecturing, question-answer	Power point presentation and course notes	Understanding the concept and giving some examples related to this
Week III	Problem Based Learning In Science Education	Presentation, lecturing, question-answer	Power point presentation and course notes	Understanding the concept and giving some examples related to this
Week IV	Project Based Learning Approach In Science Education	Presentation, lecturing, question-answer	Power point presentation and course notes	Understanding the concept and giving some examples related to this
Week V	Creating Indoor Activities In Science Education	Presentation, lecturing, question-answer	Power point presentation and course notes	Understanding the concept and giving some examples related to this
Week VI	Creating Outdoor Activities In Science Education	Presentation, lecturing, question-answer	Power point presentation and course notes	Understanding the concept and giving some examples related to this
Week VII	Teaching Concepts In Science Education	Presentation, lecturing, question-answer	Power point presentation and course notes	Understanding the concept and giving some examples related to this.
Week VIII	Creative Drama Applications in Science Education	Presentation, lecturing, question-answer	Power point presentation and course notes	Understanding the concept and giving some examples related to this

Table 3.6 Continued

Week IX	Group Presentations I.Reproduction, Growing and Development Processes of Living Things II. Light and Voice	Presentation, lecturing, question-answer, some student-centered teaching and learning approaches mostly problem-based learning		Transffering the concepts as an understandable way.
Week X	Group Presentations III. Force and Movement IV.The Structure of Matter	Presentation, lecturing, question-answer, some student-centered teaching and learning approaches mostly problem-based learning		Transffering the concepts as an understandable way
Week XI	Group Presentations V.Systems in Our Body VI. What Elements Does the Earth Consist of?	Presentation, lecturing, question-answer, some student-centered teaching and learning approaches mostly problem-based learning		Transffering the concepts as an understandable way
Week XII	Group Presentations VII. Solar System and Space VII. The Properties of Matter	Presentation, lecturing, question-answer, some student-centered teaching and learning approaches mostly problem-based learning		Transffering the concepts as an understandable way
Week XIII	Group Presentations IX. Electricity in Our Lives X. The Relationship between Living Things and Energy	Presentation, lecturing, question-answer, some student-centered teaching and learning approaches mostly problem-based learning		Transffering the concepts as an understandable way
Week XIV	Group Presentations XI. Natural Processes (Circles of Water, Air and Soil) XII. Division of Cell and Heredity	Presentation, lecturing, question-answer, some student-centered teaching and learning approaches mostly problem-based learning		Transffering the concepts as an understandable way

Table 3.6 Continued

Week XV	XIII. States of Matter and Heat	Presentation, lecturing, question-answer, some student-centered teaching and learning approaches mostly problem-based learning		Transffering the concepts as an understandable way

3.11. Treatment Verification

Treatment verification was carried out by two experts (one is the instructor of the course and the other one is a research assistant from different university in science education field) in both the experimental and the control groups. They observed the whole treatment process in two groups. The classroom notes and the Presentation Observation Forms were written down by the observers and were examined by the researcher and the observers. Moreover, the experimental group participants' responses to the interview questions considered as treatment verification.

3.12. Data Analysis

Multiple data analysis techniques were used as data were collected from various sources based on the research questions. With the aim of answering the first three research questions, data collected was analyzed by using descriptive and inferential statistical analysis methods. Reliability analysis was conducted to test the reliability of the Science process skills Test and Attitude towards Science Teaching Scale. First, the descriptive statistics were conducted to report the differences between the experimental group and control group on achievement, science process skills, attitude towards science teaching and retention. Later, Mixed Between- Within Subjects Analysis of Variance (ANOVA) with Repeated Measures was conducted for testing the hypotheses at the level of significance $\rho=0.5$. For the analysis of the data, SPSS 15.0 (Statistical Package for Social Sciences) was used.

The data obtained from the questionnaire with open ended questions and semi-structured interviews were collected together into meaningful patterns by using both the literature findings and the structure of the questions. Different codes were collected together into themes and categories. In addition to the researcher of this study, the data were coded by two different researchers (one is from science education field, and the other one is from curriculum and instruction field) to strenghten the reliability of the qualitative analysis results. Both descriptive and content analysis techniques were used to analyze the questionnaire including open-ended questions and focus group semi-structured interviews. The themes, codes and categories obtained from the essay type achievement test and open ended questionnaire were provided in the results section. Probable themes related to the questions of the questionnaire and the interviews were given in Appendix 25. Categories of the qualitative analysis were described in the results part of the study.

3.13. Assumptions of the Study

The assumptions of the study were listed as follows;

1. The participants of the study responded to the measuring instruments in an honest manner.

2. All instruments were administered to the experimental and control groups under the same conditions.

3. The experts' views about the lesson plans and measurement and evaluation tools according to the questions on the materials and the table of specifications were sufficient to provide evidence for content validity.

3.14. Limitations of the Study

1. This study was limited to the data obtained from 103 fourth grade Science Education students attending Hacettepe University Science Education Department in 2007-2008 academic year. The findings from this study was limited to the student profile and the environment of Hacettepe University. Since the sample size is limited to 103 students, it might not reflect the general population. But considering the potential regression threat, generalization could be done but homogeneity of the regression assumption could not be provided for this study. Therefore, the results of the study cannot be generalized to other contexts.

2. The characteristics of the researcher could have caused a bias during the implementation process in favor of experimental group. To minimize the internal threat to the study, two observers from the science education field controlled both the experimental and the control group by the Presentation Observation Forms. The results of the Presentation Observation Forms were used as an evidence for eliminating bias.

3. This study was limited to the content of Science Teaching Methods II Course during one semester. The general characteristics of the course were suitable to conduct constructivist based activities. It can be changed for different courses.

4. Qualitative data analysis was limited to the researcher and expert views from the field. Although literature findings and the structure of the questions contributed to the themes, the expert's perceptions and characteristics about science teaching and constructivist learning environments affected the findings.

5. Another limitation of the study was not using random selection. Because of the official permission problems and the duration of the study, two classes from Hacettepe University Faculty of Education Department of Science Education were used.

3.15. Validities of the Study

The internal validity of the results of the research study is the level at which the extraneous variables may affect the results and conclusions of the research study in addition to the group membership (Fraenkel & Wallen, 2000). Possible threats to internal validity of the results and conclusions and how they would be controlled were explained in this part.

The possible threats for the pretest posttest control group design were explained by Frankel and Wallen (2000). These threats include subject characteristics, mortality, instrument decay, history, maturation and regression.

Possible subject characteristics were identified as preservice science teachers' previous semester Science Teaching Methods I grades, pretest scores of science process skills, attitudes towards science teaching and achievement in Science Teaching Methods II course. These were compared by independent sample t-test and it was found that there was no statistically significant mean difference of the experimental and control groups' subject characteristics.

History and location threats were controlled completely because all of the measurement and evaluation tools were administered to both experimental and control groups at the same time. Also, both the experimental and the control groups had the treatment and tests at the same place. Mortality threat was controlled in this research study because there was no missing participants before or after the treatment.

Data collection conditions and procedures were observed by the instructor of the course in both the experimental and the control groups. As a result, data collector characteristics and data collector bias were controlled for this study. Testing threat was also controlled in this study. Preservice science teachers' posttest scores might be affected because of their exposure to pretest. It was controlled in that the pretest would affect both groups equally. Also, the treatment lasted for 15 weeks which allows enough time to reduce the pretest effect on the posttest.

Implementer effect was controlled in this study by presentation observation forms. The instructor of the course observed the whole treatment process and one researcher from the science education field observed the five weeks of the treatment process together with the instructor of the course. These two observers filled out the presentation observation forms and these forms were analyzed to provide treatment verification. Confidentiality was provided in this research study because the names or the physical characteristics of the preservice teachers were not written in any form. The numbers or letters were used instead of their names for matching their scores in statistical analyses.

3.16. Power Analysis

Before the treatment, the effect size was set to small ($f^2= 0.20$) since the effect of this treatment is unknown in the related literature and even a medium effect size may have practical significance. During the analyses, the probability of rejecting true null hypothesis (making Type 1 error) was specified as .05, which is commonly-used-value in the educational studies. This study involved 103 preservice science teachers and one independent variable which was investigated for its effect. For those values, the power of the study was calculated as .85. Therefore, the probability of failing to reject the false null hypothesis (making Type 2 error) was calculated as .15.

CHAPTER IV

RESULTS

The purpose of this study was to examine the effects of constructivist learning environment on pre-service science teachers' science process skills, attitudes towards science teaching and achievement. According to the research questions and hypotheses, this part covers the explanation of the findings of the science process skills test, attitude towards science teaching scale, achievement test, questionnaire and semi-structured interviews with learners that provide preservice science teachers' perceptions about the teaching and learning process in both the experimental and the control groups during Science Teaching Methods II course. Summary of the findings was given at the end of this chapter.

4.1. The Results Concerning the Equality of Groups before the Treatment

To test the equality of the experimental and control groups before the process, preservice science teachers' previous semester Science Teaching Methods I course grades, pretest scores of science process skills test, attitude towards science teaching scale and achievement test were used. Results of independent sample t-test are presented in Table 4.1, Table 4.2, Table 4.3 and Table 4.4.

Table 4.1

Results of independent t-test for previous semester science teaching methods I course grades

					Levene's Test				
Variable	Groups	*N*	*M*	*SD*	*F*	Sig.	*t*	*df*	Sig.
Previous Grades	Experimental	53	73.49	11.376	.329	.56	.79	101	.42
	Control	50	71.60	12.635					

From Table 4.1, independent t-test results showed that there was no statistically significant mean difference on previous semester Science Teaching Methods I course grades between the experimental (*M*= 73,49, *SD*= 11,376) and the control group (*M*= 71,60, *SD*= 12,635). This result indicated that students' previous semester Science Teaching Methods I course grades were similar in both the experimental group and the control group.

The normality assumption cannot be provided by Kolmogorov Smirnov Test (K-S test), but kurtiosis and skewness values between -2 and 2 can be assumed as approximately normal according to Kunnan (1998). The skewness value is -0.6 and kurtiosis value is 0.3, so it can be assumed that there is a normal distribution.

Table 4.2

Results of independent t-test for pretest scores of science process skills test

					Levene's Test				
Variable	Groups	*N*	*M*	*SD*	*F*	Sig.	*t*	*df*	Sig.
PRESPST	Experimental	53	18.47	1.887	.062	.804	1.079	101	.28
	Control	50	18.06	1.984					

From Table 4.2, independent t-test results showed that there was no statistically significant mean difference on pretest scores of science process skills test between the experimental (*M* =18.47, *SD* = 1.887) and the control group (*M* = 18.06, *SD* = 1.984). This result incicated that students' pretest scores of science process skills were similar in both experimental group and the control group.

The normality assumption was conducted with Kolmogorov-Smirnov test (K-S test). This test indicated that pretest scores of science process skills test were normally distributed for both groups *D* (53)= .10, *p*= .20 and for control group *D* (50)= .12, *p* = .20 were both normal.

Also Levene's Test which showed the equality of variances were not significantly different (*p*= .804). By looking at this value, test results were interpreted considering that equal variances were assumed and it was found that there was no statistically significant difference between the mean scores of the students in the control group and those in the experimental group on pretest scores, t (101)= 1,079, p = .283.

Table 4.3

Results of independent t-test for pretest scores of attitude towards science teaching scale

					Levene's Test				
Variable	Groups	*N*	*M*	*SD*	*F*	Sig.	*t*	*df*	Sig.
PREATSTS	Experimental	53	59.13	6.260	2.756	.10	-1.58	101	.116
	Control	50	60.88	4.788					

Looking at Table 4.3, independent t-test results showed that there was no statistically significant mean difference on pretest scores of attitudes towards science teaching between the experimental (*M* =59.13, *SD* = 6.260) and the control group (*M* = 60.88, *SD* = 4.788). This result indicated that students' pretest scores of attitudes towards science teaching were similar in both experimental group and the control group.

The normality assumption was conducted with Kolmogorov-Smirnov test (K-S test). This test indicated that pretest scores of attitudes towards science teaching were normally distributed for both groups D (53) = .12, p = .20 and for control group D (50) = .09, p = .20 were both normal.

In addition, Levene's Test which showed the equality of variances were not significantly different (p = .100). By looking at this value, test results were interpreted considering that equal variances were assumed and it was found that there was no statistically significant difference between the mean scores of the students in the control group and those in the experimental group on pretest scores, t (101) = -1.58 , p= .116.

Table 4.4
Results of independent t-test for pretest scores of achievement test

					Levene's Test				
Variable	Groups	*N*	*M*	*SD*	*F*	Sig.	*t*	*df*	Sig.
PREAT	Experimental	53	53.72	5.524	2.963	.08	0.32	101	.975
	Control	50	53.68	6.365					

Looking at Table 4.4, independent t-test results showed that there was no significant mean difference on pretest scores of achievement test between the experimental (M =53.72, SD = 5.524) and the control group (M = 53.68, SD= 6.365). This result indicated that students' pretest scores of attitudes towards science teaching were similar in both experimental group and the control group.

The normality assumption was conducted with Kolmogorov-Smirnov test (K-S test). This test indicated that pretest scores of achievement test were normally distributed for both groups D (53) = .10, p = .20 and for control group D (50) = .13, p = .20 were both normal.

In addition, Levene's Test which showed the equality of variances were not significantly different (p= .088). By looking at this value, test results were interpreted considering equal variances were assumed and it was found that there was no statistically difference between the mean scores of the students in the control group and those in the experimental group on pretest scores, t (101)= .032, p = .975.

4.2. The Results of the Achievement Test

The descriptive statistics of the pretest, posttest and retention tests of the Achievement Test were given in Table 4.5.

Table 4.5
Descriptive statistics of the PREAT, POSTAT and RAT

	Experimental			Control		
	PRECAT	POSTCAT	RCAT	PRECAT	POSTCAT	RCAT
N	53	53	53	50	50	50
Mean	**53.72**	**86.28**	**84.06**	**53.68**	**53.96**	**53.30**
Standard Dev.	5.524	6.538	6.458	6.365	6.546	6.649
Min	42	73	70	40	40	40
Max	65	100	100	65	68	66
Range	23	27	30	25	28	26
Skewness	-0.05	-0.04	-0.04	-0.21	0.11	0.01
Kurtosis	-0.31	-0.39	-0.001	-0.93	-0.68	-1.1

To compare the location and distribution of the achievement test scores, the clustered boxplot was used. The boxplot shows the middle scores which were taken in both the experimental and the control groups. The maximum scores in both the experimental and the control group were higher than the median score. The range of the scores of the experimental group means in the pretest was a little smaller than the scores of the control group. The posttest mean scores were quite higher in the experimental group when compared to the control group, in other words, pre and post test scores were almost same in control group. The range of the postest scores in both the experimental and the control groups became higher. Comparing the posttest scores; the range of the retention test scores was higher in the control group and was almost the same in the experimental group. Figure 4.1 presents the clustered boxplot of the PREAT, POSTAT and RAT for both the experimental and the control groups.

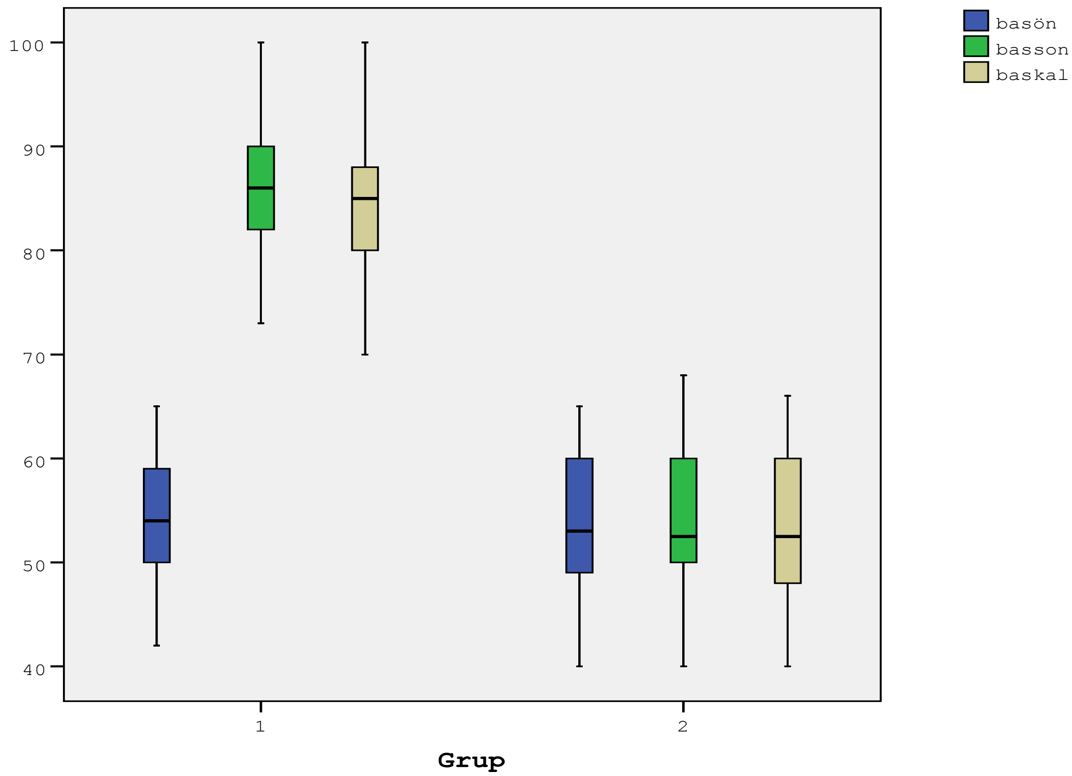

Figure 4.1 Boxplot of PREAT, POSTAT, and RAT.

The null hypothesis 1.1 and 1.2 were given as follows;

Null Hypothesis 1.1. There is no significant difference between the immediate achievement test scores of the preservice science teachers who were exposed to constructivist instruction and those who were exposed to traditional instruction.

Null Hypothesis 1.2. There is no significant difference between the retained achievement test scores of the preservice science teachers who were exposed to constructivist instruction and those who were exposed to traditional instruction.

In order to test the Null Hypothesis 3, a Mixed Between Within Subjects of ANOVA with Repeated Measures with one independent variable (treatment) with two levels (CBI and TI) and dependent variable with three levels (PREAT, POSTAT, and RAT). To investigate the effect of CBI, a 3 (pre, post and retention) X 2 (groups) ANOVA with repeated measures was employed to the achievement scores of the experimental group and the control group participants. The assumptions of ANOVA which consisted of independence of the observations, normal distribution of the dependent variables, equality of error variances and equivalence of population covariance matrices were provided for the achievement variable.

Table 4.6 shows the results of the Null Hypothesis 1 which indicates the change between the pre, the post and the retention test scores of achievement scores for experimental and the control groups taking time into consideration.

Table 4.6

The results of the 3X2 ANOVA with repeated measures of PREAT, POSTAT and RAT of the TI and CBI groups.

Source	Sum of Square	*df*	Mean Square	*F*	*p*	η^2
			Between Subjects			
Groups	34164.466	1	34164.466	323.822	.00	.76
Error	10655.883	101	105.504			
			Within Subjects			
Time (PREAT, POSTAT and RAT)	11546.526	1	11546.526	1087.027	.00	.91
Group* Time	12139.769	1	12139.769	1142.877	.00	.91
Error (Time)	1072.833	101	10.622			

A 3 (Time) x 2 (Group) mixed-model ANOVA revealed that the main effect for group was statistically significant F (1, 101) = 323.822, p = .00. This means that there was a difference in the achievement scores of participants in the experimental group when compared to the participants in the control group.

The results of ANOVA with repeated measures indicated a significant time main effect of tests scores for the pretests, F (1, 101) = 1087.027, p = .00, though this was a very large effect η^2 = .91. The indicators were defined by Cohen (1988) (.01=small effect, .06=moderate effect, .14=large effect). This means that achievement test scores after the implementation were significantly higher than before the implementation (see also in Table 4.5).

Also, there was a significant interaction effect between the time and group, F (1,101) = 323.822, p = .00. This shows that the scores of the participants in different testing times (pre, post and retention) were differed according to the groups (experimental and control).

The mean scores of the experimental group exposed to CBI and the control group exposed to TI across three different achievement scores of PREAT, POSTAT and RAT are shown in Figure 4.2. As it is seen from the figure, both the post test and the retention test scores of the experimental group was higher than the scores of the control group.

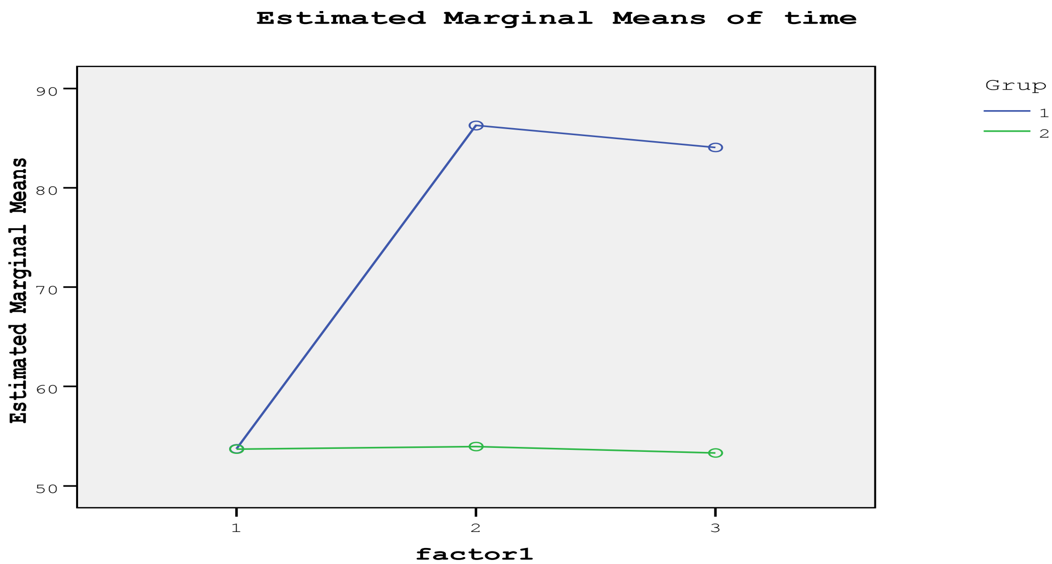

Figure 4.2 PREAT, POSTAT and RAT scores of the experimental and the control group participants (1: Experimental Group, 2: Control Group)

The paired sample *t*-test was conducted separately to test if there was a difference between the post and the retention mean scores of the achievement test in both the experimental and the control groups. The results of the *t*-test can be seen in Tables 4.7 and 4.8. As it is seen from the tables, it was found that there was a statistically significant difference between the immediate and retained achievement mean scores of the participants exposed to the constructivist instruction in the experimental group and the participants exposed to the traditional instruction in the control group. Although the experimental group's achievement immediate mean scores decreased from 86.28 to 84.06 and the control group's immediate mean scores decreased from 53.96 to 53.30; the experimental group mean scores, which was 84.06 was still higher than the control groups' achievement retained mean scores which was 53.30. There was a statistically significant mean difference in the retained scores of achievement between the experimental group who were exposed to the constructivist instruction and the control group who were exposed to traditional instruction in favor of the experimental group. The comparison of the experimental and the control groups was shown by independent sample t-test in Table 4.9.

Table 4.7

Results of t-test for POSTAT and RAT for experimental group

Group	Variable	*N*	*M*	*SD*	*t*	*df*	Sig.
Experimental	POSTAT	53	86.28	6.538	7.231	52	.00
	RAT		84.06	6.458			

Table 4.8

Results of t-test for POSTAT and RAT for control group

Group	Variable	*N*	*M*	*SD*	*t*	*df*	Sig.
Control	POSTAT	50	53.96	6.546	2.482	49	.017
	RAT		53.30	6.649			

Table 4.9

Results of independent t-test for retained scores of achievement test

					Levene's Test				
Variable	Groups	*N*	*M*	*SD*	*F*	Sig.	*t*	*df*	Sig.
RAT	Experimental	53	84.06	6.458	.877	.351	23.812	10 1	.00
	Control	50	53.30	6.649					

4.3. The Results of Attitude towards Science Teaching Scale

The descriptive statistics of the pretest, posttest and retention tests of the Attitude towards Science Teaching Scale scores were given in Table 4.10.

Table 4.10

Descriptive statistics of the PREATSTS, POSTATSTS and RATSTS

	Experimental			Control		
	PREATSTS	POSTATSTS	RATSTS	PREATSTS	POSTATSTS	RATSTS
N	53	53	53	50	50	50
Mean	**59.13**	**88.98**	**85.81**	**60.88**	**60.56**	**59.78**
Standard Dev.	6.260	6.770	6.881	4.788	5.814	5.715
Min	46	70	67	50	50	49
Max	76	102	98	70	78	75
Range	30	32	31	20	28	26
Skewness	-0.16	-0.38	-0.68	-0.09	0.56	0.45
Kurtosis	-1	-0.19	1	-0.60	0.37	-0.06

To compare the location and distribution of the attitude scale scores, the clustered boxplot was used. The boxplot shows the middle scores which were taken in both the experimental and the control groups. The maximum scores in both the experimental and the control group were higher than the median score. The range of the experimental group means for the pretest was a little smaller than the control group. The posttest mean scores were quite higher in the experimental group comparing to the control group. In other words, the pre and the post test scores were almost same in the control group. The range of the postest scores in both the experimental and the control groups became higher. Comparing the posttest scores, it was found that the range of retention test scores was smaller for both the experimental and the control groups. Figure 4.3 presents the clustered boxplot of the PREATSTS, POSTATSTS and RATSTS for both the experimental and the control groups.

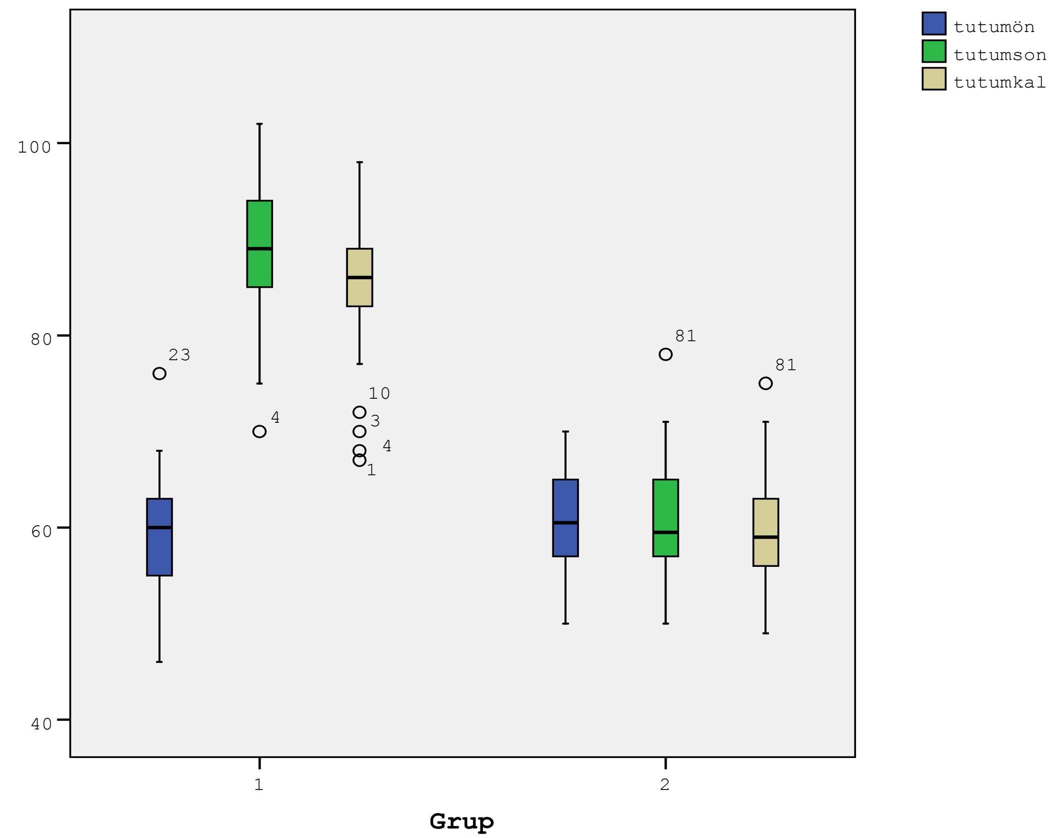

Figure 4.3 Boxplot of PREATSTS, POSTATSTS and RATSTS.

The null hypothesis 2.1 and 2.2 were given as follows;

Null Hypothesis 2.1. There is no significant difference between the immediate attitude towards science teaching scale scores of the preservice science teachers who were exposed to constructivist instruction and those who were exposed to traditional instruction.

Null Hypothesis 2.2. There is no significant difference between the retained attitude towards science teaching scale scores of the preservice science teachers who were exposed to constructivist instruction and those who were exposed to traditional instruction.

In order to test the Null Hypothesis 2, a Mixed Between Within Subjects of ANOVA with Repeated Measures with one independent variable (treatment) with two levels

(CBI and TI) and dependent variable with three levels (PRESATSTS, POSTATSTS, and RATSTS). To investigate the effect of CBI, a 3 (pre, post and retention) X 2 (groups) ANOVA with repeated measures was employed to the attitude towards science teaching scores of the experimental group and the control group participants. The assumptions of ANOVA which consisted of independence of the observations, normal distribution of the dependent variables, equality of error variances and equivalence of population covariance matrices were provided for the attitude towards science teaching variable.

Table 4.11 shows the results of the Null Hypothesis 2 which indicates the change between the pre, the post and the retention test scores of attitude towards science teaching scores for the experimental and the control groups taking time into consideration.

Table 4.11

The results of the 3X2 ANOVA with repeated measures of PREATSTS, POSTATSTS and RATSTS of the TI and CBI groups.

Source	Sum of Square	*df*	Mean Square	*F*	*p*	η^2
			Between Subjects			
Groups	23822.276	1	23822.276	266.153	.00	.72
Error	9040.093	101	89.506			
			Within Subjects			
Time (PREATSTS, POSTATSTS and RATSTS)	8416.938	1	8416.938	569.389	.00	.84
Group* Time	9927.035	1	9927.035	671.544	.00	.86
Error (Time)	1493.024	101	14.782			

A 3 (Time) x 2 (Group) mixed-model ANOVA revealed that the main effect for group was statistically significant F (1, 101) = 671.544, p = .00. This means that there was a difference in the attitude towards science teaching scores of the participants in the experimental group compared to the participants in the control group.

The results of ANOVA with repeated measures indicated a significant time main effect of tests scores for the pretests, F (1, 101) = 569.389, p = .00, though this was a very large effect η^2 = .86. The indicators were defined by Cohen (1988) (.01 =small effect, .06=moderate effect, .14=large effect). This means that attitude towards science teaching scores after the treatment were significantly higher than before the treatment (see also in Table 4.7).

Also, there was a significant interaction effect between the time and the group, F (1,101) = 671.544, p = .00. This shows that the scores of the participants in different testing times (pre, post and retention) were differed according to the groups (the experimental and the control).

The mean scores of the experimental group exposed to CBI and control group exposed to TI across three different attitude towards science teaching scores of PREATSTS, POSTATSTS and RATSTS are shown in Figure 4.4. As it is seen from the figure, both the post test and the retention test scores of the experimental group were higher than the scores of the control group.

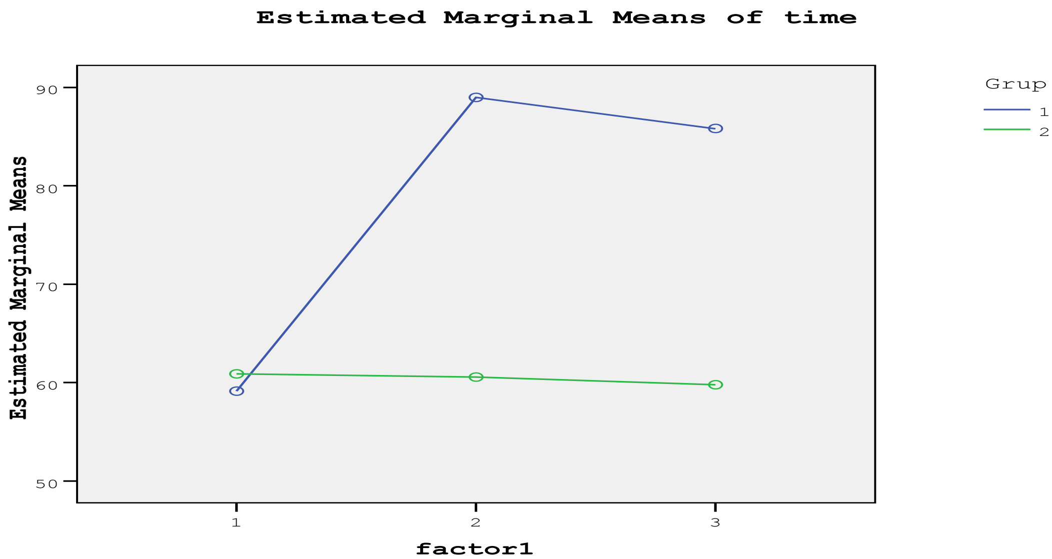

Figure 4.4 PREATSTS, POSTATSTS and RATSTS scores of the experimental and the control group participants (1: Experimental Group, 2: Control Group)

The paired sample *t*-test was conducted separately to test if there was a difference between the post and the retention mean scores of attitude towards science teaching scale in both the experimental and the control groups. The results of the *t*-test can be seen in Table 4.12 and Table 4.13. As it is seen from the tables, it was found that there was a statistically significant difference between the immediate and retained attitude towards science teaching scale mean scores of the students exposed to the constructivist based instruction in the experimental group and the students exposed to the traditional instruction in the control group. Although the experimental group's science process skills immediate mean scores decreased (from 88.98 to 85.81) and the control group's immediate mean scores decreased (from 60.56 to 59.78), the experimental group mean scores, which was 85.81 were still higher than control groups' attitude towards science teaching scale retained mean scores, which was 59.78. There was a statistically significant mean difference in the retained scores of attitude towards science teaching between the experimental group who were exposed to the constructivist based instruction and the control group who were exposed to the traditional instruction in favor of the experimental group. The comparison of the experimental and the control groups was shown by independent sample t-test in Table 4.14.

Table 4.12

Results of t-test for POSTATSTS and RATSTS for experimental group

Group	Variable	*N*	*M*	*SD*	*t*	*df*	Sig.
Experimental	POSTATSTS	53	88.98	6.770	8.011	52	.00
	RATSTS		85.81	6.881			

Table 4.13

Results of t-test for POSTATSTS and RATSTS for control group

Group	Variable	*N*	*M*	*SD*	*t*	*df*	Sig.
Control	POSTATSTS	50	60.56	5.814	2.768	49	.008
	RATSTS		59.78	5.715			

Table 4.14

Results of independent t-test for retained scores of attitude towards science teaching scale

					Levene's Test				
Variable	Groups	*N*	*M*	*SD*	*F*	Sig.	*t*	*df*	Sig.
RATSTS	Experimental	53	85.81	6.881	.467	.496	20.819	101	.00
	Control	50	59.78	5.715					

4.4. The Results of Science Process Skills Test

Descriptive statistics of pre, post and retention test scores of Science Process Skills Test were given in Table 4.15.

Table 4.15

Descriptive statistics of the PRESPST, POSTSPST, and RSPST

	Experimental			Control		
	PRESPST	POSTSPST	RSPST	PRESPST	POSTSPST	RSPST
N	53	53	53	50	50	50
Mean	**18.47**	**30.87**	**29.43**	**18.06**	**18.24**	**17.88**
Standard Dev.	1.887	2.370	2.341	1.984	2.684	2.974
Min	14	25	24	14	12	11
Max	22	35	34	22	24	24
Range	8	10	10	8	12	13
Skewness	-0.09	-0.31	-0.37	0.11	-0.06	-0.12
Kurtosis	-0.41	-0.32	-0.39	-0.67	-0.29	-0.37

To show the measures of range, median and quartiles among the variables of science process skills boxplots graphics were used (Field, 2006). To compare the location and distribution of the science process skills test scores the clustered boxplot was used. The boxplot showed the middle scores which were taken in both the experimental and the control groups. The maximum scores in both experimental and control group were few higher than median score. The range of the control group means for pretest was smaller than experimental group. The posttest mean scores were quite higher in experimental group from the control group. In other words, the pre and the post test scores were almost same in the control group. The range of the postest scores in both the experimental and the control groups became higher. To compare postest scores, the range of retention test scores for the experimental group was smaller and was almost the same for the control group. Figure 4.1 presents the clustered boxplot of the PRESPST, POSTSPST and RSPST for both the experimental and the control groups.

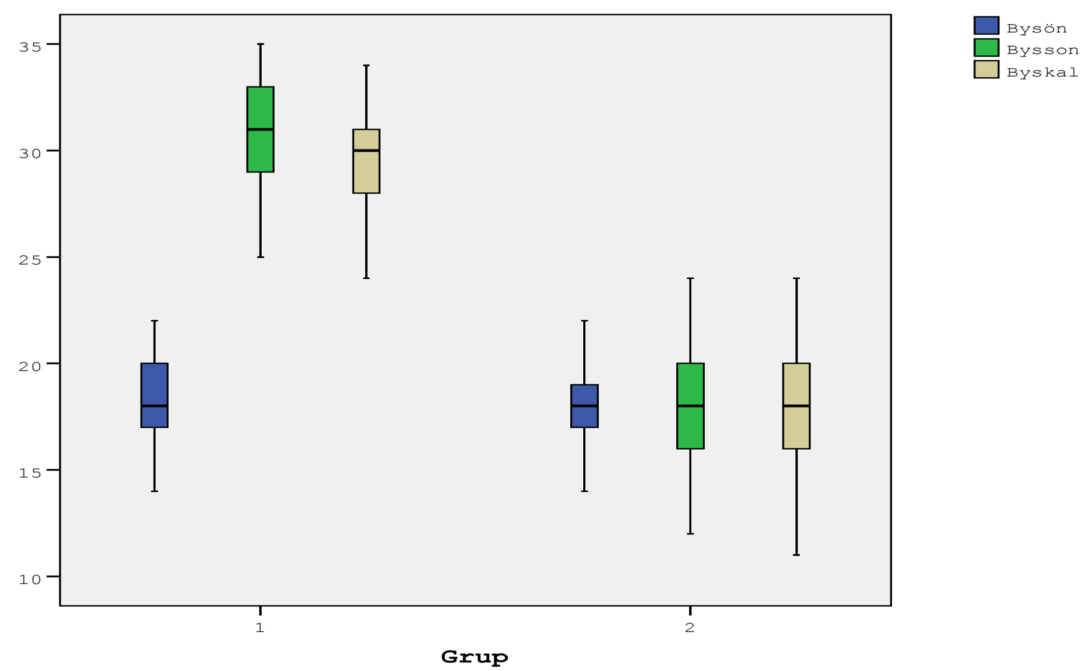

Figure 4.5 Boxplot of PRESPST, POSTSPST and RSPST.

The null hypothesis 3.1 and 3.2 were given as follows;

Null Hypothesis 3.1. There is no significant difference between the immediate science process skills scores of the preservice science teachers who were exposed to constructivist instruction and those who were exposed to traditional instruction.

Null Hypothesis 3.2. There is no significant difference between the retained science process skills scores of the preservice science teachers who were exposed to constructivist instruction and those who were exposed to traditional instruction.

In order to test the Null Hypothesis 1.1 and 1.2, a Mixed Between Within Subjects of ANOVA with Repeated Measures with one independent variable (treatment) with two levels (CBI and TI) and dependent variable with three levels (PRESPST, POSTSPST, and RSPST). To investigate the effect of CBI, a 3 (pre, post and retention) X 2 (groups) ANOVA with repeated measures was employed to the science process skills test scores of the experimental group and the control group participants. The assumptions of ANOVA which consisted of independence of the observations, normal distribution of the dependent variables, equality of error variances and equivalence of population covariance matrices were provided for the science process skills variable.

Table 4.16 shows the results of Null Hypothesis 3 which indicates change between pre, post and retention test scores of science process skills test among time for experimental and control groups.

Table 4.16

The results of the 3X2 ANOVA with repeated measures of PRESPS, POSTSPS and RSPS of the TI and CBI groups.

Source	Sum of Square	*df*	Mean Square	*F*	*p*	η^2
			Between Subjects			
Groups	5187.77	1	5187.77	386.868	.00	.79
Error	1354.211	101	13.408			
			Within Subjects			
Time (PRESPST, POSTSPST and RSPST)	1495.542	1	1495.542	556.041	.00	.84
Group* Time	1597.076	1	1597.076	593.791	.00	.85
Error (Time)	271.652	101	2.690			

A 3 (Time) x 2 (Group) mixed-model ANOVA revealed that the main effect for group was statistically significant F (1, 101) = 386.868 p = .00. This means that there was a difference in science process skills test scores of participants in the experimental group compared to the participants in the control group.

The results of ANOVA with repeated measures indicated a significant time main effect of tests scores for the pretests, F (1, 101) = 556.041, p = .00, though this was a very large effect η^2 = .85. The indicators were defined by Cohen (1988) (.01=small effect, .06=moderate effect, .14=large effect). This means that science process skills tests scores after the treatment were significantly higher than before the treatment (see also in Table 4.5).

Also, there was a significant interaction effect between the time and group, F (1,101) = 593.791, p = .00. This shows that scores of students in different testing times (pre, post and retention) differed according to the groups (experimental and control).

Mean scores of the experimental group who were exposed to CBI and the control group exposed to TI across three different science process skills scores of PRESPST, POSTSPST and RSPST are shown in Figure 4.2. As it is seen from the figure, both the post test and retention test scores for experimental group were higher than the control group.

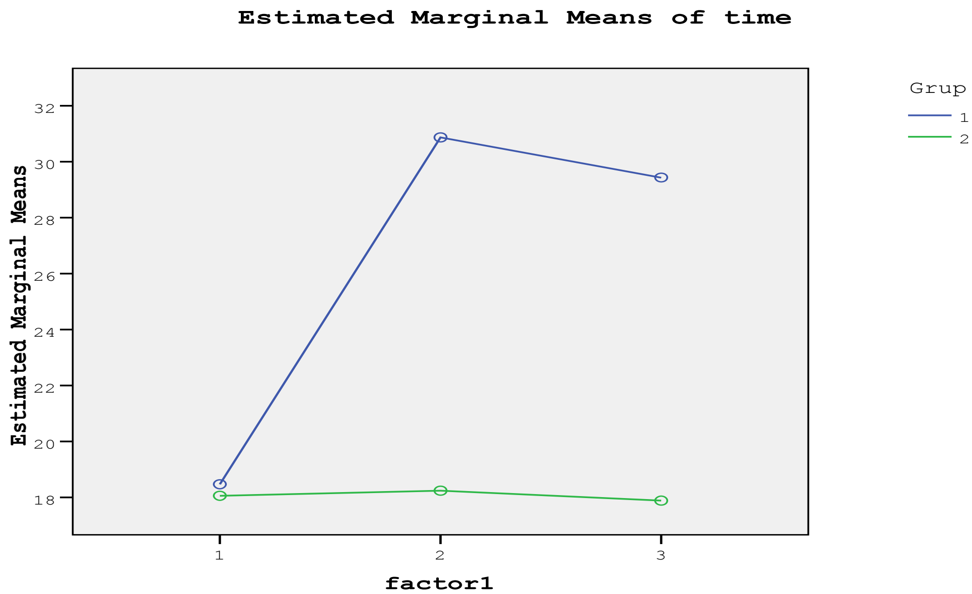

Figure 4.6 PRESPST, POSTSPST and RSPST scores of the experimental and the control group participants (1: Experimental Group, 2: Control Group)

The paired sample *t*-test was conducted separately to test if there was a difference between post and retention mean scores of science process skills test in the both experimental and the control groups. The results of the *t*-test can be seen in Table 4.17 and Table 4.18. As it is seen from the tables, it was found that there was a statistically significant difference between the immediate and retained science process skills test mean scores of the students exposed to constructivist based instruction in the experimental group and there was no statistically significant mean difference between the immediate and retention science process skills test mean scores of the students exposed to the traditional instruction. Although the experimental group's science process skills post test mean scores decreased (from 30.87 to 29.43), they were still higher than the control groups' science process skills retained mean scores which was 17.88. There was a statistically significant mean difference in retained scores of science process skills between the experimental group who were exposed to constructivist based instruction and the control group who were exposed to traditional instruction in favor of the experimental group. The comparison of the experimental and the control groups was shown by independent sample t-test in Table 4.19.

Table 4.17

Results of t-test for POSTSPST and RSPST for experimental group

Group	Variable	*N*	*M*	*SD*	*t*	*df*	Sig.
Experimental	POSTSPST	53	30.87	2.370	6.843	52	.00
	RSPST		29.43	2.341			

Table 4.18

Results of t-test for POSTSPST and RSPST for control group

Group	Variable	*N*	*M*	*SD*	*t*	*df*	Sig.
Control	POSTSPST	50	18.24	2.684	1.703	49	.095
	RSPST		17.88	2.974			

Table 4.19

Results of independent t-test for retained scores of science process skills test

					Levene's Test				
Variable	Groups	*N*	*M*	*SD*	*F*	Sig.	*t*	*df*	Sig.
RSPST	Experimental	53	29.43	2.341	2.541	.114	21.976	101	.00
	Control	50	17.88	2.974					

4.5. Summary of Results Related to Three Research Questions

According to the findings obtained from the statistical analyses of independent sample t-test and mixed between-within subjects analysis of variance with repeated measures, the following results could be summarized:

1. According to the independent t-test results, there was no statistically significant mean difference between the experimental and the control group participants' previous year Special Teaching Method I grades.

2. There were no statistically significant mean differences between the experimental and the control group participants' pretest scores of science process skills, attitudes towards science teaching and achievement scores.

3. Both descriptive statistics and the mixed between within subjects analysis of variance with repeated measures results for science process skill test results showed that there was a statistically significant mean difference between the experimental and the control group participants' immediate scores taking time into consideration. The experimental group participants' science process skills test mean scores were significantly higher than the scores of the control group participants. According to this result, it could be said that the implementation in the experimental group had a positive effect on participants' science process skills.

4. The results of descriptive statistics and the mixed between within subjects analysis of variance with repeated measures for attitude towards science teaching scale indicated that there was a statistically significant mean difference between the experimental and the control group participants' posttest scores taking time into consideration. The experimental group participants' attitude towards science teaching scale mean scores were significantly higher than control group participants' scores. According to this result, it could be said that the implementation in the experimental group had a positive effect on the participants' attitudes towards science teaching.

5. The results of descriptive statistics and the mixed between within subjects analysis of variance with repeated measures for achievement test revealed that there was a statistically significant mean difference between the experimental

and the control group participants' posttest scores taking time into consideration. The experimental group participants' achievement test mean scores were significantly higher than the control group participants' scores. According to this result, it could be said that the implementation in the experimental group had a positive effect on the participants' achievement in Science Teaching Methods II course.

6. There was a statistically significant mean difference between the post and the retention test of science process skill in the experimental group but there was no statistically significant mean difference between the post and the retention test of science process skill in the control group according to the results of descriptive statistics and the t-test results. This means that science process skills which were gained during the treatment in the experimental group changed after the implementation, but this was a small difference, which changed from 30.87 to 29.43. But the retention science process skills test scores of experimental group were still higher than the control group's retention science process skills scores.

7. There was a statistically significant mean difference in the both immediate and retained Science Process Skills Test scores between the experimental group who were exposed to the constructivist instruction and the control group who were exposed to traditional instruction, in favor of the experimental group.

8. The results of descriptive statistics and the t-test results revealed that there was a statistically significant mean difference between the immediate and the retained scores of attitude towards science teaching in the experimental and the control groups. It could be said that attitude towards science teaching which were gained during the implementation in the experimental and the control groups changed after the implementation, but these were small changes (from 88.98 to 85.81 in experimental group) and (from 60.56 to 59.78 in control group).

9. There was a statistically significant mean difference in the attitude towards science teaching between the experimental group who were exposed to the constructivist instruction and the control group who were exposed to the traditional instruction, in favor of the experimental group.

10. The results of the descriptive statistics and the t-test results revealed that there was a statistically significant mean difference between the immediate and the retained scores of achievement in the experimental and the control groups. It could be said that the achievement scores which were gained during the implementation in the experimental and the control groups changed after the implementation, but these were small changes (from 86.28 to 84.06 in the experimental group) and (from 53.96 to 53.30 in the control group).

11. There was a statistically significant mean difference in the retained achievement scores between the experimental group who were exposed to the constructivist instruction and the control group who were exposed to the traditional instruction, in favor of the experimental group.

12. According to the results of mixed between within subjects analysis of variance with repeated measures, there was a statistically significant interaction effect between the time and group for science process skill test, F (1,101) = 593.791, p = .00, $(^2$ = .85 (This was a very large effect size). This shows that science process skill test scores of students in different testing times (pre, post and retention) were differed according to the groups (experimental and control).

13. The results of mixed between within subjects analysis of variance with repeated measures revealed that there was a statistically significant interaction effect between the time and group for attitude towards science teaching scale, F (1,101) = 671.544, p = .00., $(^2$ = .86 (This was a very large effect size). This shows that the scores of participants in different testing times (pre, post and retention) differed according to the groups (experimental and control).

14. The results of mixed between within subjects analysis of variance with repeated measures indicated that there was a statistically significant interaction effect between the time and group for achievement in Science Teaching Methods II course, F (1,101) = 323.822, p = .00., $(^2$ = .76 (This was a very large effect size) This shows that the scores of the participants in different testing times (pre, post and retention) differed according to the groups (experimental and control).

15. The observed power and estimated effect size values were higher than the ones which were set at the beginning of this research study.

Both descriptive and inferential statistics results mainly revealed that there was a statistically significant mean difference between the immediate and the retained scores of science process skills, attitudes towards science teaching and achievement. The experimental group participants' immediate and retained scores of science process skill test, attitude towards science teaching scale and achievement were significantly higher than the control group participants' posttest and retention test scores. This means that the implementation in the experimental group had significant statistical effect on the participants' science process skills, attitude towards science teaching and achievement. Although quasi experimental design was selected and applied for this study and the results of inferential statistics helped to explain the statistical significance of the study with the help of estimated effect size and observed power, these results were not enough to explain the practical significance of this research study. Analysis of fourth research question which was set to identify both the experimental and the control group participants'perceptions about science teaching and constructivism and its results helped to explain the practical significance of the study.

4.6. Results of Questionnaire, Formative and Summative Interviews

For answering research question 4, a questionnaire with open ended questions was applied to both the experimental and the control group participants to identify participants' perceptions both before and after the treatment process. According to open- ended questionnaire, codes were collected under the themes which were provided in Appendix O.

4.6.1. Areas of Strenghts and Weaknesses in Science Education

The first question of the questionnaire was "How do you feel about science education? What are the parts of strenghts and needed improvement in science education?" The participants' answers were coded (See Appendix O) according to their deficiencies in science education for experimental and control groups both before and after the implementation.

Considering the codes identified according to answers which were provided by the participants in both the experimental and the control groups about preservice science teachers' areas of strenghts and weaknesses in science education, "not effectively using methods and techniques which had been learned before" had the highest frequency, which was 34 (77%) in the experimental group, "level of application" had the highest frequency, which was 34 (94%) in control group before the implementation process. "Theoretical knowledge" and "content of the Science and Technology course" had the highest frequency, which was 24 (55%) in the experimental group, "level of application" and "the measurement and evaluation" had the highest frequency, which was 35 (97%) in the control group after the implementation process. The difference between the experimental and the control groups can be seen definitely from an apparent table provided in Appendix O. Preservice science teachers from both the experimental and the control groups stated the same ideas; emphasizing that they had lack of knowledge in science education before the implementation process. However, after the implementation process; the experimental group emphasized only the content knowledge as the area of weakness, but most of the participants in the control group considered the application and measurement and evaluation processes as the areas of weakness. The missing points increased after the implementation process in the control group because they experienced school applications and recognized the possible problems in science education and identifed them in a conscious manner.

According to the themes and codes obtained from the first question in open ended questionnaire, findings regarding both experimental and control group perceptions about the areas of strengths and weaknesses in science education they felt themselves good in theoretical part of the methodologies, they had some gaps in fundamental science concepts such as heat and energy, force and weight. Both of the groups claimed that they had need more application processes about the methods and techniques in science education.

These findings indicate that both experimental and control groups had no application process about the methods and techniques in science education and they needed to complement their gaps by having more applications in both course and real classroom environments.Considering the experimental and control group participants' answers both before and after the implementation, it can be stated that they had lack of knowledge of the field and the application not just before the treatment, but after the treatment. Experimental group participants claimed that they all learned the detail parts of science education and the constructivism. They knew how to treat students in a classroom environment, but control group participants stated that there was an urgent need for application and they didn't consider themselves competent in science education. This might be because of the control group participants' teacher-centered teaching and learning process and didn't experience any application of theoretical knowledge.

In the formative interview process, same question was asked about their perceptions of science teaching and whether their expectations were fulfilled by Science Teaching

Methods II course to both high achievers and slow learners in both experimental and control group. All of the participants in focus groups had positive attitudes and perceptions of science teaching and they wanted to have more applications of the theories, principles of approaches, methods and techniques in science teaching. Some of the responses were provided about the perceptions of science teaching related to the formative focus group interview;

> Interviewee A (High Achiever) in experimental group said that *"I couldn't understand and relate the knowledge which we learned before. Lots of theoretical knowledge was given and we couldn't know how we can use these. I start to give meaning to my learnings and make some applications in science teaching…"*

Interviewee A claimed that in education courses; concepts were generally explained in a theoretical way and she never knew how to transfer what she learned into the real teaching and learning environments. This is a very important point for her. She told that she started to relate their prior learnings into a new environment and know how to transfer her knowledge into the application environments.

> Interviewee B (High achiever) from the control group;
>
> *"We learned the theoretical parts of the methods and techniques last term and also this term. We started to prepare our presentations but I have some questions about the application process of; for example brain-storming, six thinking hats, creative drama…"*

Interviewee B emphasized the lack of application parts in student-centered methods such as brain storming, six thinking hats. She thought that it is important for her presentation.

> Interviewee C (Slow learner) from the experimental group
>
> *"I started to learn how to make lesson plans, use different kinds of teaching and learning methods and techniques, concept maps, application process of problem-based learning and project-based learning. I want to make and see more applications and make interpretations…"*

Interviewee C claimed he could apply the student-centered approaches, methods and techniques in science education. He needed more application for making valid interpretations about teaching and learning.

> Interviewee D (Slow learner) from the control group
>
> *"I understand the general principles of teaching and learning methods and techniques in science education but I know that I need to do something more for effective application."*

Interviewee D emphasized for learning the theoretical background of science education. He felt the lack of application for meaningful teaching and learning.

Both high achiever and slow learner experimental group participants claimed that they knew theoretical bases of some of the learning and teaching strategies, methods and techniques before the Science Teaching Methods II course and stated that they had the opportunity to learn the application of methods and techniques in science education. Both high achiever and low achiever control group interviewees also emphasized that they learned some of the theoretical bases of methods and techniques, but they have crucial questions about the application of methods and techniques which can be used in science education. High achiever interviewee from the experimental group claimed that she couldn't make relations between their prior learnings, real teaching and learning environments. During the implementation process, both the experimental group and the control group interviewees learned the same topics during the first eight weeks, but the experimental group participants worked in groups. Different student-centered methodologies were applied in the experimental group although control group participants learned the same topics by only being lectured and question-answer methodology. The experimental group interviewees could have the opportunity to apply the steps of the interactive teaching, learning, measurement and evaluation methods and techniques by using interactive methods and techniques in this process. The experimental group interviewees emphasized that they started to apply some principles of science. According to the questionnaire results, high achiever interview participants provided more detailed and background knowledge than the slow learner participants.

In summative interview process, perceptions about science teaching, areas of strengths and weaknesses were asked to high achievers and slow learners from both experimental and control groups. The responses which were selected from the interviewees were provided under the head of above categories.

Sample quotations were given as follows;

> Interviewee A (High achiever) from the experimental group;
>
> *"The points which I feel myself good that giving detailed knowledge about the curriculum and the content knowledge. We have the opportunity to eliminate the misconceptions. We also have the opportunity of applying lots of approaches, methods and techniques. We learnt and used problem-based learning, project-based learning, brain storming. Preparing questions, creating performance activities for the measurement and evaluation process of students. These are the good points about myself. I feel one missing point. Application of the activities in real environments. I don't remember besides this."*

Interviewee A claimed that she had some misconceptions about teaching, learning and also had big gaps about the application process. She told that she mostly could use student-centered approaches, methods and techniques. Making applications of preparing questions, activities and criteria related to complementary measurement and evaluation methods and techniques. These are also the necessary elements of constructivist learning approach. She told that she wanted to make these applications in real classroom environments.

> Interviewee B (High achiever) from the control group
>
> *"Talking about strategies, methods and techniques is very good but micro teaching applications are necessary...Materials can be created from the school applications, we prepare unit plans and present in school applications. This can be used for Science Teaching Methods II course"*

Interviewee B emphasized the necessity of micro teaching applications in science education courses. She also put forward that materials could be taken from school applications for this aim and added that seeing applications in real classroom environments and discussing about them would be more effective to learn how to teach science.

Interviewee C (Slow Learner) from the experimental group;

"We learnt the curriculum in a detailed manner. We can use problem-based learning and project-based learning effectively. One of my missing points is field knowledge. For example, I have a problem in physics units. One example about problem-based learning scenario related to the bus. I can write these about biology units but cannot do for physics"

Interviewee C emphasized for content knowledge in science that lacked. He applied the problem-based learning scenarios most effectively in biology units because he had good content knowledge in biology. However, he thought that he could have problems in physics due to lack of knowledge. Although preservice teachers had lots of courses about the content of science, they should be provided with the main points as a summary in methodology courses.

Interviewee C (Slow Learner) from the control group

"We prepared and tried to our best but we don't know and estimate anything about application part…It is good for us to prepare plans but I don't know and say anything about the results"

Interviewee C wanted to see in what level his lesson plans prepared for this course could be applicable. They prepared activities having only constructed assumptions. This could be changed in different teaching and learning environments.

Considering the responses of the experimental and control group participants; it can be seen that experimental group participants had lots of good beliefs in science education. They only wanted to see the implications of their preparations in real environments. The control group participants also wanted to see the implication of what they learned, but they couldn't consider themselves highly in science education.

4.6.2. The Methods and Techniques Which Are Mostly Preferred in Science Education and The Reasons

The second question in the open ended questionnaire was "Which methods and techniques do you prefer mostly in science education?" The participants' responses were coded (See Appendix O) according to the theme of mostly selected methods and techniques in science education.

Considering the participants' responses about mostly selected methods and techniques in science education, "question-answer" had the highest frequency, which was 32 (72%) in the experimental group; "discussion" had the highest frequency, which was 26 (72%) in the control group before the implementation process. "Problem-based learning", "project-based learning" and "six thinking hats technique" had the highest frequency, which was 34 (77%) in the experimental group; "question-answer method" had the highest frequency which was 34 (94%) in the control group after the implementation process. The number of the approaches, methods and techniques increased after the implementation process in the responses provided by the experimental group. Also the experimental group participants preferred student-centered methodologies and control group participants according to their teaching and learning environment.

As for the second questionnaire, the participants' responses were coded (See Appendix O) identfying the reasons of the methods and techniques which were mostly selected.

Regarding participants' responses to the reasons of selecting of methods and techniques in science education, "developing students' science process skills and higher order thinking skills" had the highest frequency, which was 20 (46%) in the experimental group; "relating to daily life situations has the highest frequency which was 22 (61%) in control group before the implementation process; "providing students' active participation" had the highest frequency, which was 35 (80%) in the experimental group. "Providing learnings are permanent" and "providing to strengthen the knowledge" had the highest frequency, which was 22 (61%) in the control group after the implementation process. Experimental group participants provided more reasons than the control group. Although the majority of the control group participants provided reasons about knowledge, the majority of experimental group participants provided reasons about the both student skills and the characteristics of the learning environment. The reasons provided by groups change according to their teaching and learning environment.

Related to the themes and codes which obtained from the second question in open-ended questionnaire, the responses provided by the participants in the experimental and the control group about mostly selected methods and techniques in science education and the reasons of the selecting of methods and techniques in science and technology education could be summarized as follows;

Participants in both experimental and control groups stated that using both traditional and alternative teaching and learning approaches could be effective and they wanted to use them in science education. Both experimental and control groups could not state observable and measurable reasons for selection of the methods and techniques. They could not relate the application principles of methodologies into their teaching and learning environments. Experimental group participants internalized the reasons of the application procedures of methods and techniques and they could explain why they preferred a technique in a particular situation but control group participants could not differentiate the methods and techniques in science education.

Considering the experimental and control group participants' answers both before and after the implementation process, it can be stated that both of the groups' participants nearly preferred same methods and techniques and provided the similar reasons before the implementation process, but after the implementation process, experimental group participants talked about multiple student centered methods and techniques and viewed their reasons as skill-oriented but control group participants provided very few methods and techniques which could be used in classroom environment and considered their reasons as knowledge-oriented. This might because of the characteristics of their teaching and learning environments during the course process. The experimental group participants had the opportunity to learn student centered methods and techniques by using them during the course.

For the formative interview, the interviewees were asked about the approaches, methods and techniques which they mostly preferred in science education and their reasons. Both high achiever and slow learner interviewees from the experimental group preferred creative drama, problem-based learning and six thinking hats technique and the control group participants also preferred problem-based learning, project-based learning, creative drama, brain storming. According to their preferences, both the experimental and control groups' quotations were provided as follows;

> Interviewee A (High achiever) from the experimental group
> *"I feel myself good in creative drama, problem-based learning and project-based learning. We can use creative drama in every part of the lesson. I know that I should develop myself about preparing and using complementary measurement and evaluation approaches."*

This interviewee preferred creative drama, problem-based learning and project-based learning. She wanted to learn how to use complementary measurement and evaluation techniques and preparation of flashcards. She gave examples of student-centered approaches, methods and techniques in teaching, learning and measurement and evaluation process. She emphasized developing higher order thinking skills which are very important in constructivist learning approach.

> Interviewee B (High Achiever) from the control group
> *"I want to use problem-based learning. Because, it is related to daily life. For example, one audio-visual material can take students' attention."*

Interviewee B from the control group claimed that approaches, methods and techniques should help relate knowledge into real life situations. Also audio-visual materials can help gain students' attention. This participant's answer is limited because she doesn't deal with science process skills or higher order thinking skills in science education.

Interviewee C (Slow Learner) from the experimental group;

"It is very useful to use question-answer and brain-storming in classes. Preparing creative drama process will take too much time. I can prepare some rubrics and performance tasks and I feel that I could apply these in my teaching profession."

This interviewee emphasized that question-answer and brain storming techniques were very easy and useful to apply in class. He worried about taking a lenghty creative drama course to use in the classroom environment. He also had a strong belief about using process-based measurement and evaluation approaches in his teaching profession. This interviewee provided strong knowledge about application process of science education.

Interviewee D (Slow Learner) from the control group;

"Conducting experiments, project and problem-based learning are the techniques I want to use but I could not see the application process of them so although I want to use them in classroom activities"

This interviewee emphasized only the name of the approaches, methods or techniques. He didn't give information about the reasons of preferring the approaches, methods or techniques in the classroom environments. He didn't relate them to daily life and skill development in science education.

Considering the results of the formative focus group interview about the approaches, methods and techniques which were mostly preferred in science education and their reasons, the experimental group participants provided more kinds of interactive approaches, methods and techniques and more detailed knowledge about the reasons than the control group participants.

In summative interview process, both the experimental and the control group interviewees were asked about the approaches, methods and techniques which were mostly preferred in science education and their reasons. The quotations of both the experimental and the control group interviewees were provided as follows;

Interviewee A (High achiever) from the experimental group;

"I use problem-based learning scenario mostly. Because, I believe that I both develop myself and my students during the preparation process of problem scenario. We learn all the content when we prepare critical thinking questions. We can relate to the all content from easy to complicated, from concrete to abstract, also we can relate them to daily life examples. This provides to think creatively, develop positive attitudes towards science. Besides this, I use lateral methods and techniques like brainstorming and collaborative learning. I also plan use creative drama, discussion method, inquiry approach and research based learning in my classes."

Interviewee A emphasized the properties of almost all student-centered approaches, methods and techniques which could be used effectively in science. She believed that problem-based learning scenario was very useful due to many reasons such as developing critical thinking skills of students and providing meaningful learnings by relating scientific concepts into the daily life situations. She knew why and how to use student-centered methodologies in science. For instance, she stated that brainstorming and collaborative learning were the fundamental parts of problem-based learning. She also emphasized developing positive attitudes towards science. She recognized that attitudes were very important for effective learning.

Interviewee B (High achiever) from the control group;

"*Saying this or that method is not true because it can be changed for every class, every school and every individual…But recognizing classroom environment and identifying students' and environments' needs will be more suitable"*

Interviewee B stated the importance of dynamics when selecting a method or technique, but she couldn't provide exact examples related to the science education. This can be attributed to the fact that control group participants learned the methods and techniques in theory manner and interpretations were made verbally and they were not experienced any examples.

Interviewee C (Slow learner) from the experimental group;

"I love brain storming and six thinking hats technique so much. For the students' development of views. These are suitable for every content. These also can help to increase the dynamism of the class."

Interviewee C stressed usability of methods and techniques in any context and added that suitability of classroom dynamics should be considered when selecting a method. This proves that he knew the detailed parts of methods and techniques which can be used in science education.

Interviewee D (Slow learner) from the control group;

"Using different kinds of methods and techniques related to the flowchart of the topic. Everyone has individual differences. For example, creative drama method is especially effective for biology units…"

Like the other interviewee in the control group, he also claimed that any method or technique could be changed according to the topic. He believed that creative drama could be applied in only biology units as he saw theoretical examples about biology topics in instructor's presentations.

Considering the responses of the both the experimental and the control group interviewees, the control group interviewees emphasized the changeability of the methods and techniques according to topic and environment, while the experimental group participants described lots of interactive, student-centered methods and techniques. The experimental group interviewees experienced most of the interactive methods and techniques in practice.

4.6.3. The Characteristics of a Successful Science Teacher

The third question in the questionnaire was "What are the characteristics of a successful science teacher?" The participants' responses were coded (See Appendix O) according to the characteristics of successful science teacher.

According to Appendix O, about the characteristics of successful science teacher, “having content knowledge had the highest frequency, which was 32 (72%) in the experimental group; “qualified in content knowledge” had the highest frequency, which was 33 (92%) in the control group before the implementation process. “Giving importance to personal and professional development” had the highest frequency, which was 34 (77%) in the experimental group; “making laboratory activities easily” had the highest frequency, which was 25 (69%) in the control group after the implementation process. Both experimental and control groups emphasized the importance of the teachers’ knowledge of subject before the implementation process. Experimental group participants paid more importance to teaching and personal development of a teacher at the same time, the majority of the control group participants paid more importance to laboratory skills after the implementation process. Teachers’ perceptions and development are more important in constructivist learning environments and the majority of the experimental group participants internalized this property.

Related to the themes and codes which were obtained from the responses that were given to the third question, the responses provided by the participant in the experimental and control group about characteristics of a successful science teacher could be explained as follows;

Both experimental and control groups before the implementation process described the very common characteristics of a good teacher such as loving his/her job, being patient, understanding students’ characteristics…etc, but they could not relate these characteristics with constructivism and science education. After the implementation process, experimental group participants claimed that good teacher could “science concepts in proper way”, “guide rather than authoritarian” They mostly described the characteristics of a good constructivist science teacher operationally. Operational definitions could be made by learning the processes while doing. Control group participants did not change their definitions after the implementation process and still dealt with the general, stereotype characteristics of a good teacher and did not make relations with the area and the constructivist approach.

As to the experimental and control group participants' responses both before and after the implementation process, it could be understood that their definition of successful science teacher, was the same and they dealt with the general characteristics of a teacher but after the implementation process, experimental group participants operationally defined the characteristics of a good science teacher according to the Science and Technology Curriculum and also the constructivist approach but control group participants still provided general characteristics when discussing the characteristics of a good science teacher. This could be owing to the model of a teacher they saw their teaching and learning processes.

The interviewees were asked about the definition of a successful science teacher in formative interview. Both the experimental and the control group interviewees provided the general characteristics of a good teacher. In addition to this, they emphasized science process skills, using measurement and evaluation processes. Sample quotations of the definition of a successful science teacher were provided as follows;

> Interview A (High Achiever) from the experimental group
>
> *"She or he can give student-centered education, know the principles of Science and Technology Curriculum, understanding and attitudes, use the principles of Science and Technology."*

This interviewee emphasized the importance of student-centered education, understanding the main philosophy and properties of Science and Technology Curriculum which covers understanding and gaining the science process skills, beliefs and attitudes about science, using the principles of Science and Technology and relating them to the daily life situations by using both process and product based measurement and evaluation approaches. As understood from his response, it can be said that he internalized and considered the main philosophy of Science and Technology Curriculum which is based on constructivist approach.

> Interview B (High Achiever) from the control group
> *"Good science teacher can apply the methods and techniques effectively, considering students' individual differences…"*

Application of the methods and techniques in classroom environments is very important and because of this, the Interviewee B from the control group emphasized this and she added that she had some questions in her mind because she experienced teacher-oriented applications. This is a big contradiction for her.

> Interviewee C (Slow Learner) from the experimental group
> *"Successful teacher should be dominant in content, have the skill of summarization, not make differentiations between the students, and consider the individual differences of the students.."*

Interviewee C emphasized the power of content and summarization, considering the individual differences of students and organizing outdoor activities. Outdoor activities and their preparation and application processes are very important in constructivist learning approach.

> Interviewee D (Slow Learner) from the control group;
> *"Good teacher doesn't look at the students from the top. She or he is not authoritarian, be empathic and can behave like children. She or he knows and applies the measurement and evaluation approaches well."*

Interviewee D also claimed the importance of application process of measurement and evaluation process, but he generally described the general characteristics of a good teacher. He didn't provide specific explanation about the science education, science teacher and constructivism.

The experimental group interviewees defined the successful science teacher more operationally than the control group participants. The experimental group participants also defined the properties of successful constructivist teacher also. The definitions provided by the control group about the successful science teacher are very theoretical and limited. Traditional teachers can also have the properties which the control group participants claimed.

In summative interview process, the experimental and the control group interviewees were asked about the definition of a successful science teacher. The experimental group interviewees defined the characteristics of constructivist science teacher in detail, while the control group participants stated general good teacher characteristics. Quotations from both experimental and control groups were provided below;

> Interviewee A (High Achiever) from the experimental group;
> *"Teacher has absolutely the knowledge of curriculum and content. Dedicate her or himself to developments, knows the nature of science and technology, scientific process, internalizes the steps of scientific method process, knows the different ways and methods of how to make students scientific literates, knows the preparation of activities, has a researcher identity…"*

Interviwee A explained all characteristics of a successful constructivist science teacher as stated by the newly developed Science and Technology Curriculum. She emphasized science process skills, science-technology-society-environment relationships, attitude and beliefs about science.

> Interviewee B (High achiever) from the control group;
> *"I want to be a teacher who is loved by students and has content knowledge being model for students for different dimensions. I have some teachers who left good impressions on me. These kind of teachers love their professions. I want to be like them"*

Interviewee B expressed the general characteristics of a good teacher. She didn't give any specific information about constructivism and science education.

Interviewee C (Slow Learner) from the experimental group;

"I can give an example from our application schools, teachers know the vision of the curriculum, and they think that they know everything but they don't use new activities. They don't deal up with the students who sit back side of the class. They don't use the approaches like collaborative learning, creative drama.."

Interviewee C provided examples from real classroom environments. He claimed that teachers learned the principles of curriculum, but they didn't apply them. Teachers in schools used the same activities for years and didn't want to improve themselves and deal with students were not interested in the subjects.

Interviewee D (Slow Learner) from the control group;

"Teacher can provide authority and loved by everybody; teacher should love her or his profession. Teachers should follow the developments in their fields.These characteristics are important for a teacher"

Interviewee D also explained the characteristics of a general teacher and he believed that these were the most important characteristics of being a successful teacher. This be due to the fact that he couldn't see constructivist properties of a science teacher.

When investigating answers, the experimental group participants described all characteristics which teachers should do in order to provide constructivist science teaching successfully. The control group interviewees described more familiar and traditional properties of a general teacher, thought their definitions did not relate to science teaching.

4.6.4. The Place of Science Teaching Methods II Course in Science Education

The fourth question was "What is the place of Science Teaching Methods II course in science education?" The participants' responses were coded (See Appendix O) according to the place of Science Teaching Methods Course in Science Education

According to participants' responses to the place of Science Teaching Methods course in science education, "teaching methods and techniques which will be used in teaching profession" had the highest frequency, which was 35 (80%) in the experimental group, while "knowledge and application process of curriculum which was 32 (89%) in the control group before the implementation process. "Applying methods and techniques to the units in curriculum" had the highest frequency, which was 38 (86%) in the experimental group, whereas "providing learning with homework" and "course is theoretically processed" had the highest frequency, which was 32 (89%) in the control group after the implementation process. General characteristics of the course were emphasized as to place of the Science Teaching Methods II course in both the experimental and control groups. Before the implementation process, both the experimental and control groups discussed theoretical and practical phases of curriculum in this course, but the experimental group participants repeatedly stated that they applied different methods and techniques in the units of Science and Technology curriculum although the control group participants stated that Science Teaching Methods II course is theoretically based.

Related to the themes and codes which obtained from the responses that were given to the third question, the responses provided by the participants in the experimental and the control group about the place of Science Teaching Methods II course in science could be summarized as follows;

Most of the participants in both experimental and control groups stated the importance of the course by giving rules from Science and Technology Curriculum and they dealt with theoretical rules of student-centered methodologies and constructivist approach. They could not provide examples from application process to emphasize the importance of the course. Experimental group participants gave examples to show that they mostly learned all aspects of science education and had the opportunity to learn by student-centered methodologies. On the other side, control group participants tended to give similar answers as they claimed before the implementation process and complained about the lack of application in Science Teaching Methods II course

According to the experimental and control group participants' responses both before and after the implementation process, it can be stated that they all knew and emphasized the importance of Science Teaching Methods II course and the participants in both groups had expectations about application of the methods and techniques which could be used for effective science education. After the implementation process, the experimental group claimed that they all realized their expectations about application process and could explain the reasons of the importance of Science Teaching Methods II course in detail. However, the results and quotations showed that control group participants couldn't realize their expectations about application process and they all emphasized more application was needed for this course.

The interviewees were asked about the effect and importance of Science Teaching Methods II course on being a successful science teacher in formative interview process. All of the interviewees agreed that Science Teaching Methods II is the most important course in science teacher education. Related to this point, quotations of the participants from the both experimental and control groups were provided as follows;

> Interviewee A (High achiever) from the experimental group
> *"Introduction is the Material Development course. Science Teaching Methods II course is the most important course for being a successful science teacher. Studies from the beginning to this time is very good, we learn how to use group work and constructivism."*

Interviewee A emphasized the importance of Material Development course firstly and added that Science Teaching Methods II course is the most important one for being a successful science teacher.

Interviewee B (High achiever) from the control group;

"This course is very important for science teaching because we learn the principles of Science and Technology Curriculum in a detailed way. For example, I have a chance to look at from the books and learn the functions of lungs but I cannot learn how to teach from the books."

Interviewee B emphasized the importance of Science and Technology Curriculum and its properties. She claimed that way of teaching is more important than the context. She also expressed her views about Science Teaching Methods II teaching and learning process. She stated that in the course, she only learned the context, but she didn't know how to apply them to teaching and learning environments.

Interviewee C (Slow learner) from the experimental group

"First part of the Science Teaching Methods course, we gained knowledge about teaching. Science Teaching Methods II course is intended for application and helps me to understand Science and Technology Curriculum and units. We didn't know anything about the curriculum before. This course is the key for our teaching profession. I am sure that we will develop our teaching skills in the second part of the course."

Interviewee C stated that Science Teaching Methods II course provided him with the teaching skills and both the context and the necessary skills of Science and Technology Curriculum. He thought that he had never had a chance to learn the detailed sections of curriculum in addition to this course. He also believed that this course was aimed for application. He emphasized the application part since he started to make applications in theoretical part of the course, as well.

Interviewee D (Slow learner) from the control group

"It is the fundamental and the most important of the teaching courses. If I didn't take this course, I couldn't know how to teach the concepts according to students' level. This course will be more productive after making more group works and providing interactions in class."

Interviewee D stressed the importance of being aware of the cognitive level of the students and how to organize teaching and learning environments according to this course.

Considering both the experimental and the control group interviewees' responses, it can be stated that Science Teaching Methods II course has an important role in being a successful science teacher, but the experimental group interviewees emphasized the application such as group work, collaborative learning, and dynamics of constructivism. The control group interviewees claimed that they can learn the properties of Science and Technology curriculum and the general properties of methods and techniques.

Both the experimental and the control group interviewees were asked about the place of Science Teaching Methods II course in science education in summative interview process. All of the interviewees accepted that Science Teaching Methods II course has a very important role in science education, but they had different views considering the implementation process of the course. Sample quotations from both experimental and control groups were provided below;

> Interviewee A (High achiever) from the experimental group;
>
> *"The course is application-based course and it is very important for me. We can evaluate ourselves. We have a self assessment form and group assessment form. They are very positive for us. Preparing criteria before the presentations are very useful for us. Group works are very important for internalizing collaborative learning."*

Interviewee A emphasized self assessment and group assessment forms which provide critical thinking environments for both her and her friends' learning. She claimed that identifying criteria and group works were very important for effective learning environments. These characteristics also helped to be constructivist teachers.

> Interviewee B (High achiever) from the control group;
>
> "…We created good things for science education but all the things are gone off because we didn't make applications. Everything can be a problem during application. We have just only imagined. This decreases the effectiveness of the course"

Interviewee B stated that they only thought in terms of the assumptions and never considered the real environment and problems. She emphasized that the course couldn't be effective if the application parts of the theoretical bases were not discussed.

> Interviewee C (Slow learner) from the experimental group;
> *"It is absolutely very important maybe the most important course for science education. We had the curriculum and content knowledge but it is different from the other courses for their applications. I have never taken such a course before."*

Interviewee C stated that this was the first and only course in which he had an opportunity to make lots of applications. He had never seen an education course with full of applications before. He was accustomed to education courses with full of only theoretical knowledge.

> Interviewee D (Slow Learner) from the control group;
> *"I actually did not know how to prepare lesson plan, I learned this in this course. I know how to prepare daily and course plans, how to prepare and organize an activity just according to fundamental dimensions. I gained knowledge about approaches, methods and techniques but there are some gaps in application dimension. I don't know how the content of the program can bring a solution to this problem"*

Interviewee D claimed that he learned lots of things such as preparing lesson and course plans, and added that he also learned the principles of Science and Technology Curriculum but without application. According to him, it could be a very big problem and he didn't have the knowledge to solve the problems that can occur in real classroom environments.

When looking at the both the experimental and the control group interviewees' responses, experimental group participants viewed this course as an application-based course although control group participants considered application as an important gap of Science Teaching Methods II course.

4.6.5. The Parts Which Should be Improved in Science Teaching Methods I and II Courses

The fifth question is “What should be improved in Science Teaching Methods I and II courses for providing effective science education?” The participants’ responses were coded (See Appendix O) according to the parts which should be improved in Science Teaching Methods I and Science Teaching Methods II course.

According to participants’ responses about the parts which should be improved in Science Teaching Methods I and Science Teaching Methods II course; “feedback” had the highest frequency, which was 35 (80%) in the experimental group while “telling the missing sides of homework” had the highest frequency, which was 35 (97%) in the control group before the implementation process. “Recording applications in schools and then interpretation of these” and “applying the products of Science Teaching Methods II course in teaching applications in schools” had the highest frequency, which was 32 (72%) in the experimental group and “giving place to group works more”, “making discussions and giving feedback to homework”, “activities should be done for applications”, “student-centered activities should be done” had the highest frequency, which was 32 (89%) in the control group after the implementation process. Both the experimental and the control groups expressed their ideas about the feedback and telling missing sides of the homework related to Sciencel Teaching Methods I course before the implementation process. However, after the implementation process, they stated different things. The experimental group participants appreciated recording applications in schools and having the opportunity to apply and discuss the applicability of methods and techniques in elementary schools, but the control group participants wanted more student-centered and group activities during the teaching and learning process of the Science Teaching Methods II course.

Considering the themes and codes obtained from the open ended questionnaire of the third question, the responses provided by the participants in the experimental and control group about the parts which should be improved in Science Teaching Methods II course could be summarized as follows;

Both experimental and control group participants emphasized the effective organization of the theoretical science teaching concepts with applications and they wanted periodical feedback. Experimental group participants' views changed and they emphasized their fulfillment and confidence about science teaching and they needed applications in real classroom environments. Control group participants emphasized strongly that general flowchart of the course should be reorganized by considering the application opportunities in whole course process.

When looking at both the experimental and the control group participants' responses before and after the process, they all wanted the same things prior to the implementation process. After the implementation process, the experimental group participants suggested very few things, but the number of developmental points in control group increased. The experimental group participants emphasized preparing lesson plans every week and showing real classroom applications. However, the control group participants provided suggestions for every part of the course. This might be due to the fact that the experimental group had application-based teaching and learning environment and had the opportunity to apply the theoretical bases of science education to classroom environment.

4.6.6. Expectations about the Science Teaching Methods II Course

The sixth question was "What do you think about you will feel yourself about all dimensions of science education after the Science Teaching Methods II course?" This question was asked to preservice science teachers prior to the treatment process. The participants' responses were coded (See Appendix O) according to the expectations before Science Teaching Methods II course.

The participants responded to this theme before the implementation process. According to participants’ responses about the expectations before Science Teaching Methods II course, “understanding and applying the curriculum” had the highest frequency, which was 34 (77%) in the experimental group and “understanding the constructivist approach” and “application of science process skills” had the highest frequency, which was 32 (89%) in the control group. Both the experimental and the control groups had the same expectations of learning both the theoretical and the application parts of Science and Technology curriculum and understanding both the meaning and application processes of constructivist approach.

Related to the themes and codes obtained from the sixth question in the open ended questionnaire, the responses provided by the participants in the experimental and the control group about their expectations after Science Teaching Methods II course could be explained as follows;

Both experimental and control group participants expected to learn about methods, techniques and the philosophy of Science and Technology Curriculum and principles of constructivism. They mostly wanted to use the application principles of methods and techniques. This showed that there were still areas of weakness in application processes of learning and teaching methods and techniques for both two groups.

According to the experimental and control group participants’ responses just before the implementation process, they all wanted to learn how to apply methods and techniques effectively, understand constructivist learning approach, develop their science process skills and how to form group-works. This might attributed to their knowledge about Science and Technology Curriculum and theoretical bases of constructivist approach which they learned from other courses.

4.6.7. The Skills Gained After Science Teaching Methods II Course

The seventh question was "How do you feel yourself after Science Teaching Methods II course? What are the skills that you have gained after the course?" The participants' responses were coded (See Appendix O) related to the knowledge and skills which were gained after Science Teaching Methods II course.

Both the experimental and the control group participants responded to this theme after the implementation process. According to participants' responses to the gaining knowledge and skills after Science Teaching Methods II course, "the knowledge of content and curriculum," "preparation of course plans and activities," "application of approaches, methods and techniques," "understanding exactly what really constructivist approach is" had the highest frequency, which was 35 (80%) in the experimental group while "theoretical part was not productive" and "not developed so much" had the highest frequency which was 32 (89%) in control group. This difference is the most important one to understand the difference between experimental and control groups. After the implementation process, the majority of the experimental group participants emphasized that they realized their expectations, but the majority of the control group participants stated that the course process was not much effective and productive.

Related to the themes and codes obtained from the seventh question in the open ended questionnaire, the responses provided by the participants in the experimental and the control group about gaining knowledge and skills after Science Teaching Methods II course could be summarized as follows;

The experimental group participants claimed that they learned philosophy of Science and Technology Curriculum and had the opportunity to apply student-centered methodologies which the curriculum gave emphasis on after the implementation process. On the other side, control group participants stated that they could not reach their expectations and their attainments were theoretical-based.

The experimental and control group participants' responses after the implementation process showed that there was a difference between the groups. The experimental group participants emphasized that they learned all dimensions of science teaching in both theoretical and practical parts, the meaning of constructivism, and how to study in groups, but the control group participants claimed that what they learned was just theoretical and they couldn't know how to apply methods and techniques to real classroom environments. They claimed that they could learn these things via internet.

Both the experimental and the control group interviewees were asked about the skills that were gained during the implementation process of Science Methods II course during formative interview process. All of the participants put forward that they gained some skills during this course. Quotations of the participants related to this issue provided below;

> Interviewee A (High achiever) from the experimental group;
>
> *"Making observations, investigating other groups, identifying criteria, investigating according to the criteria, giving scores according to the criteria, measure, evaluate, working with groups, collaborative learning skills…."*

This interviewee emphasized the science process skills and collaborative, group working skills. These skills are the ultimate skills which can be gained after the constructivist teaching and learning process.

> Interviewee B (High achiever) from the control group;
>
> *"Observation, comprehension, understanding how to use methods and techniques in science education"*

Interviewee B stressed the comprehension and teaching skills dimensions. These are also the main objectives of the Science Teaching Methods II course and the compulsory objectives of the course.

Interviewee C (Slow Learner) from the experimental group;

"Developing my creative thinking skills, problem solving skills, observation, estimation, comparison, classifying, making concrete and valid interpretations."

Interviewee C emphasized the problem-solving, creative thinking, both fundamental and integrated science process skills. In addition to comprehension and teaching skills, these skills can be gained after constructivist teaching and learning environments and are very important to be successful and constructivist science teachers.

Interviewee D (Slow Learner) from the control group;

"Organization skill. I can plan units and concepts in science education. But I need more application for thinking myself as a teacher and estimate the classroom dynamics."

Interviewee D claimed the organization of units and concepts in Science and Technology Curriculum. He wanted more application to feel himself as a teacher and estimate the real classroom dynamics.

Considering the both experimental and control group interviewees' responses, the experimental group interviewees stressed the science process skills, problem-solving and critical thinking skills, while the control group participants mentioned about comprehension and teaching skills. Comprehension and application are the fundamental objectives of all teaching courses. The experimental group participants emphasized the group working, collaborative learning skills and almost all dimensions of science process. These skills are the implications of constructivist learning environment.

Both the experimental and the control group interviewees were asked about the skills that were gained during the implementation process of Science Teaching Methods II Course. The experimental group interviewees explained the science process skills and thinking skills in detail, whereas, the control group participants provided only the name of one or two thinking skills. Sample quotations from both experimental and control group were provided as follows;

> Interviewee A (High achiever) from the experimental group;
>
> *"Observation skills were well developed. When we see children in environment, we think about how they learn in an effective and entertaining way, imagine activities relating with the nature of the children. I can analyze what I should do and should not do in a unit. This provides to develop myself. Besides this interpretation ability, creative thinking skills were developed. Problem solving and discussion skills were developed by the help of discussing about the applicability of outcomes in a book with friends and teachers in the field. Forms that you gave us and these interviews help to develop our metacognition skills. We realized how to learn those things."*

This interviewee emphasized the importance of learning how to improve students' science process skills, critical thinking creative thinking and metacognition skills. These are the most important properties of constructivism. She informed that she understood and could apply the constructivist learning approach to teaching and learning environments.

> Interviewee B (High achiever) from the control group;
>
> *"…We did theoretical part, we couldn't transfer them to applications but we assess ourselves, groups but we don't know in what dimension we assess. We made assessment with our minds. If you gave criteria about this, our learnings could be more meaningful and presenters could prepare more effective presentations"*

Interviewee B stressed that criteria were very necessary to identify what they learned, to learn meaningfully and to create effective and valuable products.

> Interviwee C (Slow Learner) from the experimental group;
>
> *"Lots of skills but mostly creative thinking skills were developed. We constructed lots of activities for every outcome of the unit. We consider the property of originality in the activities, we learned by living and doing, we construct science stories when we go to bed at night, integrate different views, analyzing, making synthesis…"*

Interviwee C claimed that creative thinking skills were mostly improved during the preparation process of original activities for presentations. Thinking creatively and originally are the positive outcomes of constructivist learning environments since the learners created their own schema and concepts using what they learned previously.

> Interviewee D (Slow Learner) from the control group;
> *"We gained some of the critical thinking skills such as critical, creative and reflective thinking skills. There are lots of things to do for improving our skills about science teaching such as making critiques about our friends' presentations "*

Interviewee D provided only the name of thinking skills. He could not provide reasons for his explanations of these skills and their related applications in teaching and learning environments.

Considering the answers of both the experimental and the control groups, the experimental group interviewees proposed the skills related to constructivist approach and they could relate these skills to the application during the implementation process. The control group discussed some higher order thinking skills which they gained and improved during this course, but they could not relate them to the constructivist learning environments and science education.

4.6.8. Suitability of Constructivist Approach to Course

Both the experimental and the control group interviewees were asked about the suitability of the course according to constructivist approach in the formative interview process. Both the experimental and the control group interviewees stated that they could observe constructivist learning principles but the experimental group interviewees claimed that they could have a chance to observe constructivist learning and teaching principles in all parts of the course. Quotations of the both experimental and control participants related to this issue were provided below;

Interviewee A (High achiever) from the experimental group;

"Following spiral structure according to investigate the concepts from the grade level 4 to 8, application process of learnings, telling problem-based learning with the help of daily life examples, strengthening our knowledge which had been learned in last term with the help of group works. We have a holistic view about all the things we have learned."

Interviewee A emphasized the spiral structure of the curriculum and meaningful concept teaching according to the cognitive level of students. Relating to the things learnt daily life situations and having a holistic view are the integral parts of the constructivism. Also, considering prior knowledge and cognitive level of students and providing meaningful learnings are very important in constructivism.

Interviewee B (High achiever) from the control group;

"Preparation of the presentations is suitable with the constructivist approach. But, in the first part, we can see the application process of methods and techniques, we could interact each other or if criteria were identified according to the presentations, we could know how to prepare our presentations and follow our friends."

Interviewee B claimed that only the presentations were appropriate with the constructivist approach, but transferring teaching methods by verbalism. She also told that they had the opportunity to learn clues about the preparation process of the presentations by only watching other groups. She emphasized that more interaction and group works were needed in the theoretical part of the course and she stressed the necessity of identifying criteria before the presentations.

Interviewee C (Slow learner) from the experimental group;

"We all skimmed our knowledge. Activities were prepared according to the prior knowledge and experiences. Other applications are suitable also for the collaborative learning dimension of constructivism; for example presentation observation forms, peer evaluation forms and self evaluation forms."

Interviewee C emphasized the priority of considering prior knowledge of students and collaborative learning indicators such as presentation observation forms, peer evaluation forms and self evaluation forms which serve the main characteristics of constructivism.

> Interviewee D (Slow Learner) from the control group;
> *"I want to make an application after the presentation process of problem-based learning and project-based learning. Learners' prior experiences should be considered for effective teaching but we cannot have the chance to relate our prior learnings to our new ones"*

Interviewee D emphasized the lack of practice during the implementation process of the course. He also claimed that the approaches, methods and techniques which they learned were student-centered; however, they didn't make some applications about this.

Considering the answers of the interviewees; the experimental group interviewees stated that the characteristics of the constructivist learning environment could be observed in their teaching and learning environment such as considering prior knowledge, gaining holistic view about concepts and methodologies, peer evaluation form, self evaluation form and presentation observation forms. Although the control group participants were not aware of the applications in the experimental group, they emphasized that they needed application and interaction regarding both theoretical and presentation parts of the course as both experimental and control groups knew the characteristics of constructivist approach.

Both the experimental and the control group interviewees were asked about the points that are related to the constructivist approach in Science Teaching Methods II course in summative interview process again. The experimental group interviewees provided valuable statements about constructivist approach, but the control group participants had little motivation and emphasized only the application parts. Sample quotations from both experimental and control groups were provided as follows;

Interviewee A (High achiever) from the experimental group;

"You use our prior learnings and experiences, then construct new interactive learning environment on prior learnings. Identfying criteria with us is a wonderful activity. You syntheses these criteria and prepared check list. We made critiques on the forms. We had an intense group work. Then it is very useful for our group works. We were responsible for both our and the others' learnings. When I investigate the lesson plans, our first criteria is the suitability of the constructivism."

Interviewee A emphasized that making lots of applications using prior knowledge, preparing criteria and checklists, being responsible of her own and others' learning, making original activities, asking critical thinking questions and relating learnings into the daily life situations were the indicators of constructivist learning environment she was also very happy to involve in this learning environment. Metacognitive characteristics, inquiry, complementary process-based measurement and evaluation are the important characteristics of constructivist approach.

Interviewee B (High achiever) from the control group;

"You take our views in classroom but it is not enough to apply constructivist approach. You could plan activities by considering our needs and prior experiences. We did not have the opportunity to put new things on our previous attainments"

Interviewee B's motivation decreased after the implementation process because during the implementation process, his opinions were asked related to creating constructivist learning environments, but he couldn't observe the constructivist learning principles during the implementation process.

Interviewee C (Slow Learner) from the experimental group;

"The big effects of group evaluation form, self evaluation form and presentation observation form. The effect of our views on the other groups motivate to listen the other groups carefully and effort of other groups, group studies developed our communication skills, being respectful for others' views, we recognized how to learn, we spent effort to prepare lesson plans according to constructivism."

Interviewee C also stressed on group evaluation form, self evaluation form and presentation observation forms which provided students with the opportunity to listen the presentations and gain metacognitive skills, group working abilities which are very important to create constructivist learning environments.

> Interviewee D (Slow Learner) from the control group;
> *"…Unfortunately we didn't learn by living and doing. You are respectful for us but there are more things to create constructivist learning environments. For example we could assess our presentations and make some discussions about them. We could identify our gaps about science teaching. This could help us to see the application process of constructivism"*

Learning by living and doing is the key statement of constructivism. Interviewee D claimed that he couldn't observe such a learning environment during the implementation process.

Considering the answers of the both experimental and control groups, the experimental group interviewees defined the characteristics of learning environment taking into consideration their teaching and learning process in Science Teaching Method II course. The control group participants also were aware of the characteristics of constructivist learning environments. However, they complained about the fact that they couldn't see these characteristics in their teaching and learning environments.

4.6.9. The Things Which Can be Done For Improving the Science Teaching II Course According to the Constructivist Approach

The things which can be done for improving Science Teaching II course according to constructivist approach were asked during formative interview process. Examples of high achiever and slow learners' quotations and their interpretations from both experimental and control group were stated as follows;

Interviewee A (High achiever) from the experimental group;

"More applications can be added to Science Teaching Methods I course and these two courses can be given in one year. Also the criteria also can be prepared for the activies which were done in first eight weeks."

Interviewee A stated that Science Teaching Methods I course is theoretical-based and it should have more applications in that course to provide background for Science Teaching Methods II course.

Interviewee B (High achiever) from the control group;

"We could observe ourselves, our friends according to criteria which we made. Courses can be processed with more applications"

Interviewee B emphasized the importance of criteria before presenting the lesson plans. She also claimed the lack of application in Science Teaching Methods II course.

Interviewee C (Slow Learner) from the experimental group;

"Our friends can apply one daily plan on ourselves. We can ask questions like a student. It is not proper for time but it will be very good."

Interviewee C claimed that acting as a student during the presentations. Also constructing real classroom environments would be useful for the planning process of this course.

Interviewee D (Slow Learner) from the control group;

"Using real environment materials will be very meaningful and related to the constructivist approach. Making more group works and applications will be very useful for realizing constructivism in classroom environments."

Interviewee D claimed the importance of group works. He stated that group works are related with the main idea of constructivist approach.

According to the responses of the interviewees, having two sections of this course in one year, identifying criteria for the first eight weeks and applying unit or daily plans to real elementary classroom environments are what the experimental group interviewees stressed. The control group interviewees emphasized more group works and applications for make the course to be constructivist.

Both the experimental and the control group interviewees were asked about the areas of weakness that can be changed or improved according to the constructivist approach in Science Teaching Methods II course in summative interview process also. Both groups provided some suggestions about this topic, but the control group repeatedly emphasized the application process. Sample quotations from the both experimental and control groups were provided as follows;

> Interviewee A (High achiever) from the experimental group;
>
> *"You gave critical questions at the end of the process; these questions can be given from the beginning to the end. Also we could prepare daily plans all week. This provides to be dominant in all topics of the curriculum.*

Interviewee A claimed that every process of implementation process could be controlled by critical thinking questions and this could be dominant in every parts of Science and Technology curriculum. This is an important point to develop holistic view and to apply constructivist learning approach.

> Interviewee B (High achiever) from the control group;
>
> *"Micro teaching applications should be done really…Doing more applications in Science Teaching Methods II course is very important although Science Teaching Methods I course can be theoretical"*

Interviewee B stressed microteaching applications in parallel with the formative group interview and she claimed that although Science Teaching Methods I which is the prerequisite course of Science Teaching Methods II course can be theoretical, Science Teaching Methods II course should cover practical applications of the theoretical parts. She couldn't observe these application parts during the implementation process in addition to the presentations.

> Interviewee C (Slow Learner) from the experimental group;
>
> *"Preparing daily plans will be very useful for us. For example, I don't feel myself very good at Matter and Heat unit. But, I can prepare lots of activities*

in biology units. I also have very detailed skills and knowledge about teaching as a profession."

Interviewee C provided suggestions in paralled with the first one from the experimental group. Preparing daily plans for every week for every unit could be more productive to understand and apply each part of Science and Technology Curriculum.

Interviewee D (Slow Learner) from the control group;

"We only talk about the applications. Application dimension covers the communication skills. It is a big gap about communication in this course. You should interact with us and we should interact with you and our friends during the process"

Interviewee D stressed on communication skills. He claimed that interaction should be done around the students and instructor during the teaching and learning processes and interaction was needed for providing constructivist teaching and learning environments.

According to the interviewees' responses from both the experimental and the control group, experimental group participants suggested all students could prepare lesson plans every week. They believed that this application could prove to be dominant for all units and parts of Science and Technology curriculum. The control group interviewees discussed the gaps of communication and suggested providing more interactive teaching and learning environment.

4.6.10. The Effect of Presentation Observation Forms

The experimental group interviewees were asked about the effect of presentation observation forms which were prepared by them before their presentations during the formative interview process. Related to this point, quotations of the interviewees from the experimental group were provided as follows;

Interviewee A (High achiever) from the experimental group

"Identifying criteria is very important for the preparation and action of the presentations. This process develops our responsibility and quality of our work."

Interviewee A stated that students' preparing criteria was very important and it shaped to their presentations. She claimed that they started to learn how to learn, take their own responsibility of learning and preparation. This process increased their quality of work. She summarized the metacognitive learning process which is an important part of constructivist learning approach.

Interviewee C (Slow Learner) from the experimental group
"Preparing presentation evaluation forms makes the assessment process more objective and we develop our assessment and science process skills."

Interviewee C talked about the skill development during the criteria preparation. He added that this identification made the assessment process more objective. He explained the priorities of complementary measurement and evaluation approaches.

Both the high achiever and slow learner experimental group interviewees emphasized the importance and usability of presentation observation forms. The female participant stressed the metacognitive and collaborative effects of observation forms while female participants emphasized the positive effect of observation forms on science process and critical thinking skills.

4.6.11. The Reason Why Teachers in Science Education Don't Improve Themselves

Interview C from the experimental group who provided the characteristics of teachers in real classroom environments wanted to explain the reasons why the science teachers don't improve themselves during summative interview process

Interviewee C (Slow Learner) from the experimental group;

"They are not graduated from the Faculty of Education first. They have knowledge about the curriculum later. Involuntariness situation is dominant around them. Maybe that's because of they don't want to develop themselves and use the same activities in class for years."

Interviewee C claimed that graduation from Faculty of Education has an important role in acting in class successfully. Preservice teachers gain special knowledge in education faculties and have the opportunity to see and apply what they have learned in real classroom environments. This theme was constructed during the interview. This participant emphasized the importance of having education courses effectively in undergraduate education.

4.6.12. The Parts that should be Improved in General Teaching Courses to Educate Successful Teachers

According to their answers, only experimental group interviewees were asked about the parts that should be improved in general teaching courses to educate successful teachers and the interviewees suggested taking courses intended for classroom application during summative interview process.

Interviewee A (High achiever) from the experimental group;

"For example, new course about problem-based learning can be opened. General content of the course can be covered talking about problems, creating critical thinking questions and problem scenarios about every topic and discipline in Science and Technology curriculum. I want to have such a lesson."

Interviewee A emphasized on problem-based learning and its applications in science education. She claimed that preparing critical thinking questions, organizing any topic according to problem-based learning is very important.

Interviewee C (Slow learner) from the experimental group;

"The courses can be intended for applications. We can have the opportunity to apply the activities in the schools. You can observe us and we can observe our

friends, the applicability of the activities and plans can be investigated by this.”

He stressed some of the courses should be dedicated to the application. He added that there should be micro-teaching applications and observations in science teaching. Interviewee C was constructed in one of the experimental focus group interviews. Two of the experimental group participants suggested opening new courses to benefit from the interactive methods and techniques in science education and relating Science Teaching Methods II course to school applications and creating interactive learning environments with elementary schools and teacher education level.

4.7. Summary of the Questionnaire and Semi Structured Interview Results

The findings related to the questionnaire and semi structured focus group interviews were summarized as follows;

1. The experimental group and the control group participants discussed the same areas of strength and weakness which they consider themselves competent and incompetent in science education. After the treatment process, the experimental group participants claimed that they compensated for their lack of knowledge and skills although the control group participants emphasized all areas of weakness which they had expressed before. Interactive teaching and learning environments, making lots of applications, having periodical feedbacks and having a role in measurement and evaluation process fulfilled the expectations of the experimental group participants and they had the opportunity to compensate for their lack of knowledge and skills. On the other side, the control group were lectured through theoretical based course and had almost no interaction. This process could not help them to complement their lack of knowledge and skills in science education.

2. The experimental group participants defined multiple, process-based and student-centered teaching and learning approaches, methods and techniques and provided their reasons by observable and measurable examples, while the control group participants

preferred more limited, product-based and traditional teaching and learning approaches, methods and techniques after the treatment process . Using student-centered methodologies in their learning process did help the experimental group participants to understand and define their application characteristics easily.

3. It could be understood from answers to the questionnaire that experimental group participants internalized the constructivist learning approach and could define all the skills which could be gained upon involving in the constructivist based learning environment and they could explain their reasons. However, the control group participants didn't recognize and internalize the constructivist learning environment and they defined skills which could be gained upon involving in any learning environment which follows the implementation process.

4. After the implementation process, experimental group participants operationally defined the characteristics of a good science teacher according to the Science and Technology Curriculum and also the constructivist approach. However, control group participants still described traditional and general characteristics when describing the characteristics of a good science teacher. The control group participants observed the traditional teacher in classroom environment although they read about the characteristics of successful science teacher in the Science and Technology Curriculum or books.

5. The experimental group claimed that they all realized their expectations which they had emphasized before, but the control group claimed that they couldn't realize their expectations such as understanding what really constructivism is, the application procedures of methods and techniques in the course. The teaching and learning environments that they had been exposed to might be the reason of these responses. The experimental group had the opportunity to make effective applications, but theoretical-based lessons were investigated in their teaching and learning environments.

6. The results of the questionnaire and semi structured interviews showed that experimental group participants were more successful in science education and they had a strong belief to organize constructivist based science classes and use student-centered methods and techniques in teaching and learning processes. This result is in parallel with the inferential statistics results of science process skills, attitudes towards science teaching and achievement. The experimental group participants had more positive attitudes towards science teaching and they were more successful in both scientific process and teaching skills than the control group participants.

7. Using group works, self and group assessment forms during the teaching and learning processes and applications the experimental group participants provided to experience and act as constructivist teachers and develop their teaching abilities. The control group participants had conflicts about the theory which they learned and teaching and learning processes in class. They emphasized that applications of methods and techniques should be done in Science Teaching Methods II course. They didn't consider themselves competent in teaching, science process skills. These results were also in parallel with the inferential statistics results of science process skills, attitudes towards science teaching and achievement.

CHAPTER V

DISCUSSION

The purpose of this study was to investigate the effects of constructivist based instruction on preservice science teachers' Science Teaching Methods II achievement, science process skills and attitudes towards science teaching. Also perceptions of both experimental and control groups' participants were identified about the implementation process, science teaching and constructivism. Conclusions were provided firstly and then external and internal validities of the study were stated. Conclusions of the study were presented in the next section. The final section was devoted to the recommendations for practices and further research studies.

5.1. Conclusion

Conclusions of this research study drawn from the findings according to the research problems are stated as follows;

5.1.1. The Effect of Constructivist Based Instruction on Achievement

One of the research problems of this research study was to find out if there was a statistically significant difference in the achievement scores between the participants in the experimental group who were subjected to constructivist based instruction and the participants in the control group who were subjected to traditional instruction.

The posttest results showed that there was a statistically significant mean difference between the experimental and control group's achievement in favor of experimental group. Similarly, in other research studies, achievement mean scores became higher and these mean differences were statistically significant in favor of the groups which had been exposed to teaching and learning environments according to constructivist learning model than the groups who had traditional instructions in their teaching and learning processes (Akar, 2003; Akcay, 2007; Akkuş et al. ,2003; Connoly & Beqq, 2006; Gatlin, 1998; Hamlin, 2001; Koç, 2002, Savaş, 2006; Şengül, 2006; Thomson & Soyibo, 2002; Uzuntiryaki, 2003; Yurdakul, 2004).

The findings obtained from the retention test of achievement also showed that there was a statistically significant mean difference between experimental and control groups in favor of experimental group.

The results of the data analysis showed that there was a strong increase in preservice science teachers' achievement scores in favor of experimental group and this change was not statistically permanent after ten weeks for both experimental and control groups. The skill, achievement and attitude mean scores of both experimental and control groups were decreased. This conclusion is in contrast with Akar (2003). Although the mean differences were not high in both the experimental and control group, knowledge and skills were decreased among time. Although the treatment had a strong effect in the experimental group, this decrease was due to the fact that the experimental group participants could not see such environments after the treatment. Experimental group participants should have been in constructivist based teaching and learning environments after the treatment process. Also learning environments should be revised for providing permanent knowledge and skills.

5.1.2. The Effect of Constructivist Based Instruction on Science process skills

The posttest results which related to the second research question and hypothesis showed that there was a statistically significant mean difference between the experimental and control group's science process skills obtained through Scientific Process Skill Test (SPS) in favor of experimental group who had teaching and learning environments according to constructivist learning theory. This finding was in parallel with Koç (2002); Scherz et al. (2005) and Önal (2005) studies.

Constructivist based learning environments helped the students to express themselves, think about how they learn, relate their learnings into the daily life situations, be respectful of others' ideas, think critically, creatively and reflectively (Yager, 1991). Higher order thinking skills are very important in effective science education and also skill development is more important than the learning content (Kaptan, 1999). Students can be higher order thinkers if they interact with constructivist teaching and learning environments. Teachers can create and provide these environments for their students. Due to the fact that, organizing teacher education courses have much importance for educating constructivist teachers, constructivist teaching and learning environments provided for preservice science teachers in this study.

The findings obtained from the retention test of science process skills test showed that there was a statistically significant mean difference between the experimental and control groups in favor of the experimental group. Koç (2002) stated that there was a statistically significant mean difference between higher order thinking scores of experimental group participants who had constructivist learning environments than control group who had traditional learning environments with a study group of 180 students.

The t-test conducted for comparing immediate and retained scores of science process skills showed that although the amount of changes seemed to be small, there was a statistically significant mean difference between immediate and retained scores of science process skills in both experimental and control groups. Retained scores were less than immediate scores. Science process skills which were gained after the treatment process were not permanent. This decrease was due to the fact that preservice science teachers could not have the opportunity to apply their skills effectively in teaching and learning environments.

5.1.3. The Effect of Constructivist Based Instruction on Attitude towards Science Teaching

Third research problem of this study investigated if there was a statistically significant mean difference in the attitude towards science teaching scores between the participants in the experimental group who were subjected to constructivist based instruction and the participants in the control group who were subjected to traditional instruction.

The posttest results showed that there was a statistically significant mean difference between the experimental and control group's attitudes towards science teaching through a five point likert scale in favor of the experimental group. This means that posttest findings of the research study indicated that attitude scores towards science teaching increased after the implementation and this increase was statistically significant in favor of the group which had teaching and learning environment according to constructivist learning theory than the group who had traditional instruction in their teaching and learning processes. (Uzuntiryaki, 2003; Savaş, 2006; Akcay, 2007). On the contrary, Akar (2003) found that the attitude scale mean scores of the control group who had traditional learning environment were significantly higher than experimental group who had constructivist learning environment. The cognitive load of the experimental group is considered as the reason of this finding. The findings which were obtained from the retention test of attitudes towards science teaching showed that there was a statistically significant mean difference between experimental and control groups in favor of the experimental group. The retention test scores were not commonly calculated for attitude in the other research studies, but considering the duration of the experiment procedure and time between post and retention tests, it was expected that retention test give valid results.

The t-test which was conducted for comparing immediate and retained scores of attitude towards science teaching showed that there was a statistically significant mean difference between immediate and retained scores of science process skills.

Retained scores were lower than immediate scores. Attitudes towards science teaching gained after the treatment process were not permanent. Experimental group participants' attitude towards science teaching scores were decreased due to the fact that they couldn't have the opportunity to be in constructivist-based learning environments and apply student-centered methodologies in science education.

5.1.4. Conclusions Drawn From the Research Problem 4 According to the Participants' Perceptions About Science Education and Constructivist Learning Environments

5.1.4.1. Areas of Strenghts and Weaknesses in Science Education

According to the open ended questionnaire and focus group interview results, both experimental and control groups claimed that they needed more application in the field about the approaches, methods and techniques which can be used in science education and interactive learning environments in their classrooms. They also emphasized their lack of knowledge in their field of study. Using constructivism as a learning approach in classrooms is not an easy process. Yager (1991) provided suggestions for realizing constructivist classrooms where activities, opportunities, tools and environments are provided to encourage metacognition, self-analysis, self-regulation, self reflection and self awareness and problem-solving, higher-order thinking skills and deep understanding. Following the implementation process, the experimental group participants claimed that they had a positive attitude for making applications and extending their teaching skills according to constructivist learning approach. They also informed that they had interactive teaching and learning environments where they could make their own decisions about their assessment, study in groups and share different ideas, have feedback about their studies periodically, and the opportunity to relate their learnings into the daily life situations. This finding is similar to the studies conducted by Davies (2003) and Connoly and Beqq (2006).

5.1.4.2. Mostly Preferred Methods and Techniques in Science Education

The participants who were exposed to constructivist based instruction during the implementation process mostly preferred interactive engagement methods which were firstly explained by Hake (1998) and they provided reasons with operational definitions about them. Participants who were exposed to traditional instruction mostly preferred teacher-centered methodologies since they mostly had them in their learning process. This finding is similar to Watts' (2003) ideas suggesting that the teachers plan their teaching environment according to their prior experiences. Stenger& Garfingel (2003) stated that preservice teachers had deep knowledge and developed higher order thinking skills when they performed in constructivist learning environments. Tytler (2002) suggested that examining the students' needs and describing their characteristics was necessary for organizing creative and effective learning environments. This is similar to Yager's (1991) constructivist classroom where learning is knowledge construction, interpreting world, constructing meaning, authentic experience and process oriented.

5.1.4.3. The Definition of a Successful Science Teacher

The participants who were exposed to constructivist based instruction during the implementation process defined successful science teacher as a constructivist teacher and they provided operational definitions about them. Properties of using alternative, student-centered teaching, learning, measurement and evaluation techniques, providing individual and colloborative learning environments according to students' developmental levels and learning styles and giving importance to science process skills were given as the characteristics of a contructivist science teacher as defined by Yager (1991). Participants who were exposed to traditional instruction provided more common characteristics such as enjoying the work and teaching, and valuing the students. These results are very similar with Akcay, 2007; Freedman, 1998; Hartle, 2007.

5.1.4.4. The Place of Science Teaching Methods Course in Science Education

The participants who were exposed to constructivist learning environments claimed that they benefited from interactive learning environments, changed their misconceptions, internalized the characteristics of a well-equipped teacher, had experience on how to organize and apply different approaches, methods and techniques in science education. However, the participants who were exposed to traditional instruction claimed that the course was theoretically based, with lack of applications. These results are similar to the ones stated by Akcay, 2007 and Grosshans, 2006. The results of these research studies showed that traditional, theoretical-based instructions were not fulfilled preservice teachers' expectations about teaching and learning.

5.1.4.5. The Parts Which Should be Improved in Science Teaching Methods II Course

Comparing the experimental group participants who were exposed to constructivist based instruction with the control group participants who were exposed to traditional instruction, the experimental group participants' expectancies related to Science Teaching Methods II course were decreased while control group participants' expectancies were increased. The experimental group participants wished to see the school applications of the course, but the control group participants wanted to have more applications during the course process. This result is very similar to the results of Plourde and Alawiye, 2003. This research study emphasized a strong meaningful correlation between the learners' expectations and the process that they live.

5.1.4.6. Expectations before Science Teaching Methods II Course

Both the experimental and the control group participants who were exposed to constructivist based instruction and traditional instruction wanted to understand the constructivist approach, prepare lesson plans, apply methods and techniques according to constructivist approach in classroom environments. The preservice science teachers in experimental group stated that they could ease at applying the curriculum in their future teaching profession but preservice science teachers in control group were concerned about understanding and applying the vision of curriculum. This conclusion is very similar to the one by Plourde and Alawiye (2003) who found high positive relationship between the preservice teachers' beliefs towards the constructivist knowledge and the application of it and also Sercoussi (2005), who conducted a research study to examine the relationship between the teachers' perceptions and the quality of implementation and again found accepted correlation coefficients between them.

5.1.4.7. Knowledge and Skills Which Were Gained after Science Teaching Methods II Course

The experimental group participants who had constructivist based instruction gained skills such as using complementary assessment techniques, application of approaches, methods and techniques in science education, understanding exactly what really constructivist approach is and how to apply them considering the necessities of the constructivist approach and its applications in classroom environments. The control group emphasized the ineffectiveness of the application process in this category. This is due to the type of implementation. The experimental group participants learned what the constructivist approach is through invitation, research-exploration, proposing explanations, solutions and taking actions in the class. They used lots of audio-visual materials, process based teaching, learning, measurement and evaluation approaches, methods and techniques. However, the participants in the control group used teacher centered, more strict activities without deep thinking processes. This result is similar to the ones suggested by Tsai (2002), who conducted a study to investigate the relationships among teachers' beliefs about teaching science, learning science and the nature of science and Scherz et al. (2005), who described an instructional model for developing higher order skills.

5.2. Discussion

It is difficult to load just one term to constructivism. It is commonly assumed as a philosophy or an approach in education. Many developed countries in the world applied the constructivist approach and benefited from what it provides before it is implemented in Turkey. This approach became important in Turkey after the developments and improvements in curricula development process in both primary and secondary education in the year of 2000. Science and Technology Curriculum was developed under the light of constructivist approach although there was not enough theoretical and practical background for science teachers to apply the approach in their classrooms. Although pilot schools were selected for the application of the newly developed curricula, they did not have enough knowledge and practice to use interactive engagement methods according to constructivist approach in classrooms. The changes in the curricula in primary and secondary level caused the changes in preservice education level. Preservice science education programs were changed by Higher Education Council in 2006 on the basis of changes in elementary and secondary curricula. The education in preservice science education was not planned according to constructivist approach. This research study provided findings and discussion according to the constructivist approach in preservice science education and showed that using constructivist based instruction (CBI) in teaching and learning environments affect preservice science teachers' beliefs and abilities during science teaching.

Research studies about constructivist based curricula showed that teacher beliefs are the integral part of the developmental process of constructivist curricula before instructional design was organized. As for this, understanding of the intended curriculum is crucial before assessing the learning outcomes. Teacher beliefs have the most important role in this process (Aikenhead, 2000).

The results of the study also served the findings of Project Synthesis, which was emphasized by Harms and Yager (1981) and these findings referred four important goals of science education. These goals are, teaching science for meeting personal needs, resolving societal issues, raising career awareness and preparing for further studies. The constructivist based instruction provided an opportunity for preservice science teachers to consider their students' needs, relate science concepts and principles to the daily life situations, raise career awareness and relate prior learnings to the new situations and learning environments.

In the early times, the schools provided only science content knowledge with lecture based instruction but today both primary and secondary education give importance to students' skill development and the integration of different disciplines in science education. This can be done by constructivist based science curricula (Yager, 2001). The constructivist based science curricula can be implemented by constructivist science teachers. Hence, preservice teacher education has an important role in shaping student teachers' perceptions about teaching and learning processes.

Science teacher education programs need to be improved by informing the preservice science teachers about the application of new instructional strategies, measurement and evaluation approaches, methods and techniques (Dass, 1999). Therefore, interaction between science, technology and society should be provided to preservice science teachers by organizing teacher education programs (Yager, 1990). Akcay (2007) claimed that preservice science teachers develop more meaningful learning and deeper understandings of teaching and learning strategies and needed to develop science process skills and an organizational scheme to scientific knowledge. He also added that preservice science teachers learn science by using the constructivist approach during teaching and learning processes.

The results of this research study showed that constructivist instruction provided preservice science teachers with the opportunity to improve their understanding of constructivist learning and teaching environments. This finding is in parallel with the review article of Hudson (2004), who stressed the importance of constructivist mentoring including scaffolding, facilitating and coaching processes. These are considered crucial in constructivist science education. Also, Plourde and Alawiye (2003) stated that the correlation coefficient for the student teachers' beliefs towards constructivist knowledge and application had a relationship (r =.76). This means that if the student teachers' knowledge of constructivism increased, their belief that they would be "able to apply constructivist principles in the classroom learning situation" tended to increase.

Creating constructivist learning environments for preservice science teachers motivated them and increased their positive beliefs and attitudes towards effective science teaching. Researchers in science education generally dealt with applications of constructivism in primary and secondary education level. It should also be remembered that constructivist teaching and learning environments can be created by well educated preservice teachers. In other words, teachers have very important roles in creating constructivist teaching and learning environments. Due to the holistic nature of constructivist approach, preservice teachers should internalize application principles of interactive engagement methodologies and apply them in proper situations. Prospective science teachers could apply constructivist teaching and learning strategies after they have been exposed to constructivist teaching and learning environments. Due to the fact that organizing both preservice and inservice science teacher curricula by observable and measurable outcomes and activities are very important for providing effective teaching and learning environments related to constructivist approach. This could be provided by conducting many more research studies in both elementary and preservice education level in a parallel pattern in Turkey. One of the key points of this research study is avoiding overgeneralizations because as constructivist approach considers social aspects of societies and their characteristics, its application procedures can differ in various social contexts. Therefore, it is difficult to claim that using one method in teaching and learning environments can be effective according to constructivist learning approach.

5.3. Recommendations

Taking the results of the study into consideration, recommendations to the science educators in the field who are the instructors of the education courses, program developers and to the researchers for future research studies are presented in the following section.

5.3.1. Recommendations for Practice

1. The constructivist based instruction according to Yager's (1991) model, which consists of invitation, research-exploration, proposing explanations and solutions and conclusion-taking action was effective for developing preservice science teachers' science process skills. These skills are crucial for teacher education and primary science education considering the Science and Technology Curriculum. As a result, constructivist based education can be used for the development of science process skills in science teacher education level.
2. Constructivist based instruction according to Yager's (1991) model was effective in increasing attitude towards science teaching and this plays an important role in organizing teaching and learning environment for science teachers in primary level. This type of instruction can be used in science education and also in other disciplines of education to increase attitudes of preservice teachers.
3. Constructivist based instruction according to Yager's (1991) model played an important role in developing preservice science teachers' achievement. This type of instruction could be used for developing teaching skills of the preservice teachers in other education courses.
4. Preservice science teachers' behaviors and teaching abilities can be observed and compared to the groups who were exposed to constructivist based instruction and the groups who were exposed to traditional instruction in the real classroom environments during school applications in primary level.

5. Both preservice and inservice training in the constructivist based instruction can be conducted and their possible effects in the classroom environments can be observed.
6. Interactive workshops or application procedures can be provided by the field experts or the educators to use student-centered methods and techniques such as creative drama, problem-based learning in science education during the education courses.
7. Periodical feedback can be provided to the preservice science teachers about their studies to make them have the responsibility of their own learning. This is one of the main principles of constructivist learning approach.
8. Process-based complementary assessment methods and techniques which are very important for constructivist learning can be used in science teacher education to follow the development of preservice science teachers in different dimensions.
9. Preservice science education curricula can be revised considering the developments according to Science and Technology Curriculum in elementary level.
10. Inservice teacher education could be organized and defined in a systematic manner according to constructivist approach and developments in elementary curricula.
11. Micro teaching applications can be conducted in both preservice and inservice science education levels.
12. Collaboration with Ministry of National Education and Higher Education Council can be useful for making effective application in science education.

5.3.2. Recommendations for Further Research

Following recommendations for further research are presented below according to the results and findings obtained from this research study;

1. This research study was limited to the fourth grade preservice science teachers in Hacettepe University Faculty of Education Department of Science Education. Therefore, similar studies can be replicated with a larger sample size to generalize the results and findings to a larger population.
2. Further research studies can be conducted for different grade levels of science education and other education courses.
3. Similar research studies can be conducted for different subject matters and disciplines such as mathematics education and for different levels.
4. Research studies in the future can be conducted in primary level and teacher education at the same time to show the implications of the methodology.
5. Since the random assignment was not possible for sampling procedure and quasi- experimental research design was used for this study, further research studies can be done with true experimental designs with random sampling.
6. Since the assumptions of the Multivariate Analysis of Covariance (MANCOVA) were not satisfied for this research study, further studies should perform MANCOVA analysis to find the effects of the confounding variables such as gender, previous semester grades, pretest scores…etc.
7. Further research studies can be conducted by considering the variables of preservice science teachers' motivation, self efficacy, teacher thinking, decision making and planning processes.
8. Longitudinal research studies can be designed for further research to examine the effect of constructivist based instruction in a longer period.
9. Replication studies of this research study can be conducted with larger samples to be able to make valid generalizations in the preservice science education. Larger samples provide the opportunity use multivariate statistical techniques easily considering their assumptions.
10. Research studies on the developmental process of preservice science education curricula can be conducted to apply student-centered methodologies and to understand constructivist approach better.

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APPENDICES

APPENDIX A

Science Process Skills Test (Bilimsel Süreç Becerileri Testi)

Sevgili Öğretmen Adayları;
Bu çalışmanın amacı, Fen Bilgisi öğretmen adaylarının bilimsel süreç becerilerini ölçmek, bu becerileri geliştirmeye yönelik etkinlikler tasarlayıp onların gelişimini izlemektir. Bu amaçla hazırlanan ölçme aracında fen ve teknoloji ünitelerinde yer alan konular kapsamında, ancak içerikteki bilgileri yoklamaktan ziyade, beceri ölçmeye yönelik 36 adet çoktan seçmeli soru bulunmaktadır.

Vereceğiniz cevaplar, araştırmanın sonuçlarının güvenirliği açısından büyük önem taşımaktadır.

Ölçme aracında her soruya ait A'dan D'ye kadar dört adet seçenek bulunmaktadır. Her soruyu dikkatle okuyup size uygun gelen seçeneği cevap kağıdı üzerinde, sorunun karşılık geldiği seçeneğin altındaki parantezin içerisine X ile belirterek işaretleyiniz. Her soru için tek seçenek işaretlemeniz önemle rica olunur.

Değerli katkılarınız için teşekkür ederim.

İlke ÖNAL
ODTÜ Eğitim Fakültesi
Eğitim Bilimleri Bölümü Doktora Öğrencisi

	A	B	C	D		A	B	C	D
1.	( )	( )	( )	( )	19.	( )	( )	( )	( )
2.	( )	( )	( )	( )	20.	( )	( )	( )	( )
3.	( )	( )	( )	( )	21.	( )	( )	( )	( )
4.	( )	( )	( )	( )	22.	( )	( )	( )	( )
5.	( )	( )	( )	( )	23.	( )	( )	( )	( )
6.	( )	( )	( )	( )	24.	( )	( )	( )	( )
7.	( )	( )	( )	( )	25.	( )	( )	( )	( )
8.	( )	( )	( )	( )	26.	( )	( )	( )	( )
9.	( )	( )	( )	( )	27.	( )	( )	( )	( )
10.	( )	( )	( )	( )	28.	( )	( )	( )	( )
11.	( )	( )	( )	( )	29.	( )	( )	( )	( )
12.	( )	( )	( )	( )	30.	( )	( )	( )	( )
13.	( )	( )	( )	( )	31.	( )	( )	( )	( )
14.	( )	( )	( )	( )	32.	( )	( )	( )	( )
15.	( )	( )	( )	( )	33.	( )	( )	( )	( )
16.	( )	( )	( )	( )	34.	( )	( )	( )	( )
17.	( )	( )	( )	( )	35.	( )	( )	( )	( )
18.	( )	( )	( )	( )	36.	( )	( )	( )	( )

BİLİMSEL SÜREÇ BECERİLERİNİ ÖLÇMEYE YÖNELİK FEN BİLGİSİ TEST SORULARI:

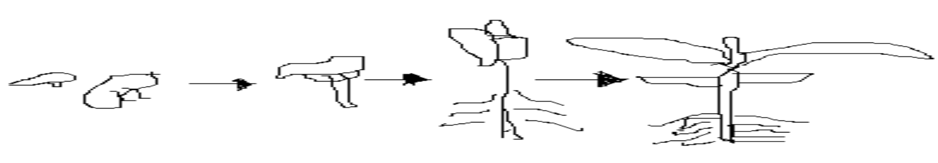
1. Yoğurt mayalama süreci,kaynatılmış sütün yaklaşık 35-40 santigrat dereceye getirilerek az miktar yoğurt eklenmesiyle ve bu karşımın aynı sıcaklıkta belli bir süre bekletilmesiyle gerçekleşir.
Aşağıdaki prensiplerin hangisi bu sürecin açıklanmasında etkili değildir?

A) Yoğurt mayalamada faydalı bakteriler etkilidir.
B) Süt,bir çok vitamin,mineral ve protein içerir.
C) Çoğu bakteriler,düşük ya da yüksek sıcaklıkta faaliyet gösteremez.
D) Bakteriler;katı,sıvı ve gaz olmak üzere her türlü ortamda yaşayabilir.

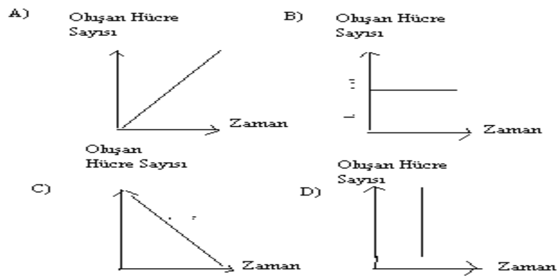
2. Sıcak bir kaloriferin üzerine koyulan kağıt parçalarının bir süre sonra hareket ettiği gözlemlenir.
Aşağıdaki olaylardan hangisi bu durumun dayandığı ilkeye örnek teşkil eder?

A) Isıyı dışarıya daha iyi iletebilmeleri için elektrik sobalarının iç yüzeylerinin alüminyum kağıt ile kaplanması
B) İçi toprak dolu bir kavanoza sıcak su döküldüğünde dışarıya hava kabarcıklarının çıktığının gözlenmesi
C) Bazı kuş türlerinin kendilerini sıcak hava akımına bırakarak kanatlarını hiç çırpmadan gökyüzüne yükselmeleri
D) Güneşin en tepede olduğu saatlerde kumsalda çıplak ayakla yürünememesi

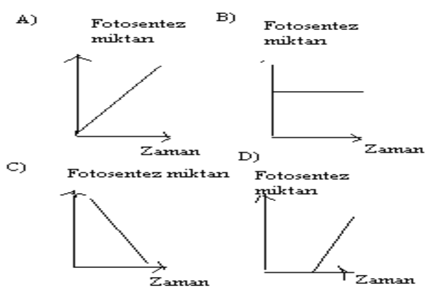
3. 3 ve 4. soruları aşağıdaki bilgiye göre cevaplayınız.
Aşağıda fasulye tohumunun çimlenmesinden ergin bir fasulye bitkisinin oluşum süreci gösterilmiştir.



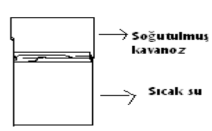
3. Bu süreçte oluşan hücre sayısının zamana göre değişimi aşağıdakilerden hangisinde doğru verilmiştir?



4. Bu süreçteki fotosentez miktarının zamana göre değişimi aşağıdakilerden hangisinde doğru gösterilmiştir?



5. Bir öğrenci,aşağıdaki şekilde gösterildiği gibi içi sıcak su dolu kavanozun üzerine içinde buz bekletilerek soğutulmuş boş bir kavanoz kapatıyor.



30 saniye sonra üstte bulunan kavanozda buğulanma ve su damlacıklarını gözlüyor.Öğrenci,bu deneyi aşağıda belirtilen sorulardan hangisini cevaplamak için yapmış olabilir?
A)Yağmur nasıl oluşur?
B) Isınan hava genleşir mi?
C) Buz sıvı hale geçerken hacmi değişir mi?
D) Suyun içerisinde hava boşlukları var mıdır?

6. Ağzına kadar su ile dolu bir kaba evdeki aile bireylerinin ayaklarını dizlerine kadar daldırma işlemini yapan bir çocuk aşağıdaki sonuçlardan hangisi ya da hangilerine ulaşabilir?

I.Kaptan taşan su miktarı,aile bireylerinin ayaklarının hacmini verir.
II.Ayakkabı numarası büyük olan kişinin taşırdığı su miktarı daha fazladır.
III.Taşan su miktarı,aile bireylerinin vücut yoğunluklarına bağlıdır.

A)Yalnız I B)Yalnız II C) I ve II D) I,II ve III

7. 'İçine bir miktar sıvı kolonya konulan bir balon sıcak suya daldırılıyor.Bir süre sonra balonun içinin kuru olduğu gözleniyor.Bu durum aşağıdakilerin hangisiyle açıklanabilir?
A) Gazların sıvılar içerisindeki çözünürlüğüyle
B) Balonun taşırdığı suyun balonun hacmine eşit olduğuyla
C) Sıcaklık ile çözünürlük arasındaki ilişkiyle
D) Isıtılan sıvıların gaz haline geçmesiyle

8. 'Bazı maddeler sıcaklık etkisi altında yeni maddelere dönüşebilir.'
Aşağıdaki olayların hangisi bu duruma örnek olarak gösterilebilir?
A) Kibritin yanması
B) Isınan havanın yükselmesi
C) Kapağı sıkışmış şişelerin sıcak su yardımıyla açılması
D) Buzun erimesi

9. Suyun üzerine mürekkep,sıvı yağ damlatıp daha sonra da bunları pamuk,kağıt havlu ve kuş tüyü gibi maddeler kullanarak ayırmaya çalışan bir öğretmen aşağıdaki durumlardan hangisine dikkat çekmek istemiş olabilir?
A) Mürekkep ile yağın özkütlesi birbirinden farklıdır.
B) İçerisine yağ nüfuz etmiş sıvılar,kağıt ve pamuk gibi maddeler yardımı ile daha kolay ayrılabilir.
C) Denizlere dökülen petrol gibi yağlı maddeler kuş gibi canlıların yaşamını olumsuz yönde etkileyebilir.
D) Suyu yağdan arındırabilmek için mürekkep kullanılması gereklidir.

10. Aşağıdaki olayların hangisinde rüzgarın bir etkisi yoktur?
A) Uçurtmanın uçmasında
B) Kayaçların parçalanmasında
C) Bitki tohumlarının çevreye yayılmasında
D) Ele kolonya döküldüğünde serinleme hissedilmesinde

11. Farklı ortamlarda yaşayan bitki türlerinde zaman geçtikçe bitki bölümlerinde,bitkinin bulunduğu ortamda yaşama şanslarını arttıran bir takım değişiklikler ve uyumlar oluşur.
Aşağıdakilerden hangisi bu değişikliklere örnek verilemez?
A)Dağlarda yetişen bitkilerin çiçeklerinin renklerinin daha solgun olması
B)Çöl bitkilerinin geniş bir alandan besleyici madde ve su alabilmeleri için birbirinden uzakta yetişmeleri
C)Kaktüs bitkisinin üzerindeki dikenlerin su kaybını en aza indirecek şekilde sıralanması
D) Bataklık bölgelerinde yetişen ağaçların uzun ve geniş yapraklı olması

12.

Canlı Türü	**Üreme sıklığı (Yılda)**	**Bir doğumdaki yavru sayısı (en fazla)**	**Yaklaşık gebelik süresi (gün)**
Ev faresi	7-8	13	21
Tavşan	6-7	6	42
Köpek	2	10	60
Fil	2 yılda bir	1	660

Yukarıdaki tabloda verilen bilgilerle aşağıdaki sonuçlardan hangisine ulaşılamaz?

A) Gebelik süresi büyük vücutlu canlılardan daha uzundur.
B) Çoğalma miktarı küçük vücutlu canlılarda daha fazladır.
C) Üreme sıklığı çevre koşulları ile ilişkilidir.
D) Bir doğumdaki yavru sayısı en büyük vücutlu canlıda en azdır.

13. Bir canlı türünün farklı ortamlarda yaşayan bireyleri arasında bazı fiziksel farklılıklar gözlenmektedir.
Aşağıdakilerden hangisi buna örnek olarak verilebilir?
A) Sıcak bölge tilkilerinin,soğuk bölge tilkilerinden daha büyük kulaklı olması
B) Soğuk bölgelerde yaşayan kutup ayısının daha çok deniz ürünleri ile beslenmesi
C) Balinalarda ön üyelerin yerini yüzgeçlerin alması
D) Martının ayaklarındaki perdenin leyleğinkinden geniş olması

14. ’Evrende kızgın bir gaz ve toz kütlesiydim.Kendi eksenim çevresinde dönmeye başlamadan önce,düzgün bir biçimim yoktu.Süreç içerisinde dıştan içe doğru soğumaya başlarken,yapımdaki ağır maddeler merkezime doğru toplanmaya başladı.Bu ağır maddeler birleşerek ‘yeryuvarı’ denilen katı küremi oluşturdu.’
Bu hikayeyi dinleyen bir öğrenci yer küre hakkında aşağıdaki sonuçlardan hangisine ulaşamaz?
A)Yer kürenin merkezinin çok sıcak olduğu
B)Yer kürenin dış yüzeyinin katı olduğu
C)Yer kürenin dıştan içe doğru katmanlardan oluştuğu
D)Yer kürenin yapısının metalce zengin olduğu

15. Deniz kenarında kum üzerine yazılan yazı ya da şekli çıkarılan nesneleri bir öğrenci günlük hayatta karşılaştığı aşağıdaki soruların hangisi ile ilişkilendirebilir?
A) Su,bütün canlılar için yaşam kaynağı mıdır?
B) Kumun üzerindeki şekiller su etkisi ile yok olacak mı?
C) Canlılar yeryüzünde bıraktıkları izler,su rüzgar gibi etkenlerle aşınıp kaybolabilir mi?
D) Kumun içerisinde var olan mineraller yaşamsal etkinliklerin bir göstergesi midir?

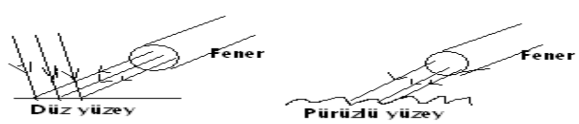
16. 'Virüsler,ışık mikroskobunda dahi görülemeyecek küçüklükte canlılardır.'ifadesi aşağıda verilen açıklamaların hangisini doğrular?
A) Virüsler,sadece elektron mikroskobunda görülebilen canlılardır.
B)Virüsler,çeşitlerine göre vücudun farklı hücrelerine girerek canlılık özelliği gösterirler.
C)Virüsün baş kısmındaki kılıf,virüsün kalıtsal maddesidir ve onu dış etkenlerden korur.
D)Virüslerin nasıl üredikleri ve nereden gelip hastalık oluşturdukları tam olarak bilinmektedir.

17. Bir elmanın kabuğunu soyup birkaç gün beklettikten sonra kabuklu bir elma ile karşılaştıran bir öğrenci aşağıdaki bağlantılardan hangisini kurabilir?
A) Elmanın kabuğu vitamince zengin maddelerden oluşmuştur.
B)Elmayı kabuğuyla yemek sağlık açısından faydalıdır.
C)Elmanın kabuğunda elmanın gelişmesi için birtakım üreme hücreleri bulunur.
D)Elmanın kabuğu,elmayı dış etkilerden koruyan insan vücudundaki deri işlevini görür.

18. Bir kavanoza fasulye koyup gözleri bağlı bir öğrenciden, kavanozu sallayıp sesin geldiği yeri göstermesini isteyen bir araştırmacı,aşağıdaki bilgilerden hangisini kanıtlamak istemektedir?

A) Ses,etkileştiği cismin özelliğine göre farklı nitelikte olabilir.
B) İnsan kulağı,farklı yönlerden gelen ses dalgalarını ayırt edebilir.
C) Ses dalgaları,bulundukları ortamda değişik yollar izleyebilir.
D) Ses,bulunduğu ortamda doğrusal ya da dalgalar halinde yayılabilir.

19. Değişik seviyelerde su doldurulmuş cam kaplara eşit kuvvetlerle vurulduğunda değişik seslerin çıktığı fark edilir.
Bu durum aşağıdakilerden hangisi ile açıklanabilir?
A) Cam kaplarda bulunan suyun yoğunluğu ile
B) Suyun içerisinde bulunan maddelerin oluşacak ses miktarına etkisi ile
C) Oluşan sesin tınısının sıvının kaba temas ettiği yüzeyin büyüklüğüyle olan ilişkisi ile
D)Bir ses kaynağının farklı ortamlarda farklı titreşimler oluşturması ile
20.



Yukarıdaki şekilde düz ve pürüzlü bir yüzeye fener yardımı ile ışık ışınları verilmektedir.Düz yüzeyde birbirine paralel ve düzgün olarak yansıyan ışık ışınlarının pürüzlü yüzeyde nasıl davranması beklenir?
A) Işık ışınları dağınık yansır.
B) Yansıma bulunan ortama bağlı olmadığından ışınlar düzgün ve paralel yansır.
C) Düz olmayan yüzeylerde yansıma olayı gözlenmez.
D) Dağınık olarak yansıyan ışık ışınlarının bir süre sonra netleştiği gözlenir.

21. Çölde ilerleyen bir kişinin uzakta su birikintisi gördüğünü sanıp yaklaştıkça su birikintisinin olmadığını görmesi ışığın hangi özelliği ile açıklanabilir?

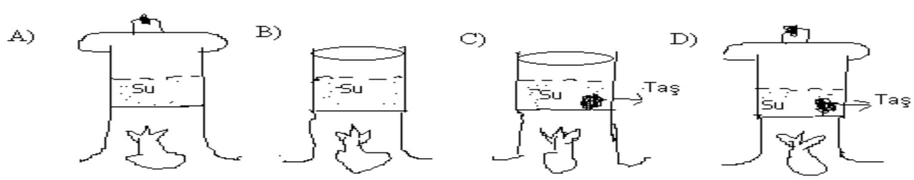
I.Kırılma
II.Süzme
III.Tam Yansıma
IV.Geçirgenlik
A) I ve II   B)I ve III   C)I,II ve III   D)I,II,III ve IV

22. Ses,dalga özelliği gösterir.Buna göre;aşağıdaki olaylardan hangisi ya da hangileri sesin yansımasının sonucudur?

I.Elin kulak arkasına koyulduğunda ve kulak kepçesinin yüzey alanı büyütüldüğünde sesin daha iyi duyulması
II.Kapalı bir alanda konuşulanların açık bir alanda konuşulanlardan daha net duyulması
III.İnsanların duyamadığı bazı seslerin köpekler tarafından duyulması
A)Yalnız I   B) I ve II   C) I ve III   D) II ve III

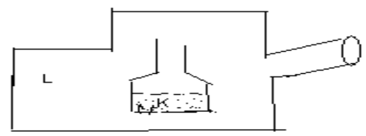
23. Bir sıvının üzerindeki hava basıncı,sıvının kaynama sıcaklığını etkiler.Basınç arttıkça kaynama sıcaklığı yükselir,azaldıkça düşer.
Aşağıdaki olaylardan hangisi bu duruma örnek gösterilebilir?
A) Deniz kenarında suyun,dağdakine göre daha yüksek sıcaklıkta kaynaması
B) Dağda alkolün,sudan daha düşük sıcaklıkta kaynaması
C) Deniz kenarında suyun sütten daha düşük sıcaklıkta kaynaması
D) Dağda bir litre suyun,iki litre sudan daha çabuk kaynaması

24. Başlangıç sıcaklıkları aynı olan aşağıdaki düzeneklerde eşit miktarlarda su bulunmaktadır. Bu düzenekler özdeş ısıtıcılarla ısıtıldıklarında hangisindeki su diğerlerinden daha çabuk kaynar?



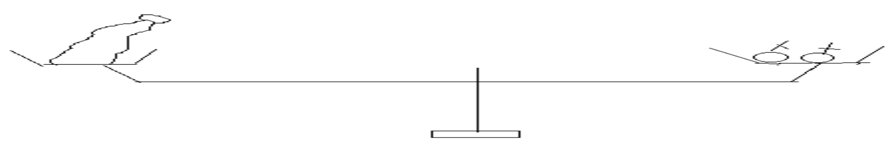
25. 'Isınan gazlar genleşir,soğuyan gazlar büzülür.'
Aşağıdaki durumlardan hangisi buna örnek verilebilir?
A) Yazın uçakların daha kolay yükselmesi
B) Yanmakta olan masa lambasının altındaki balonun şişerek buzdolabına konulan balonun büzülmesi
C) Elimize sürdüğümüz kolonyanın bir süre sonra uçup gitmesi
D) Bağlantı yerlerinde gerekli boşlukların bırakılmadığı tren raylarının yazın genleşince bozulması

26. Bir öğrenci, aşağıdaki şekilde verilen iç içe geçmiş iki kabın K bölümünde sıcak çay saklamak istemektedir.Kabın L bölümüne aşağıda verilen maddelerin hangisi konulursa kabıniçindeki çay <u>daha geç</u> soğur?



A) Oda sıcaklığında alkol
B) Soğuk su
C) Sıcak kum
D) Oda sıcaklığında su

27.

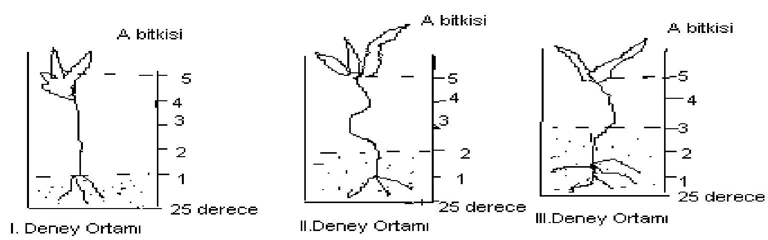


Yukarıdaki terazinin kefelerinde kütleleri eşit olmak üzere açıkta ve şeffaf naylon torba içinde portakallar bulunmaktadır.Bu sistemde bir süre gözlem yapan bir kişi aşağıdaki hangi soruya doğrudan cevap <u>veremez</u>?
A) Havayla teması azaltılan besinler daha uzun süre dayanır mı?
B) Havayla teması azaltılan besinler,daha az su kaybeder mi?
C) Havayla teması azaltılan besinler daha az kütlelerini kaybeder mi?
D) Havayla teması azaltılan besinler,vitaminlerini daha çok koruyabilir mi?

28. 'Bir cismin,sabit kabul edilen bir noktaya göre bulunduğu yerden başka bir yere giderse konumu değişir.'
Bu bilgiye göre aşağıdaki durumlardan hangisinde konum değişikliği olmuştur?
I.Sabah evden çıkıp akşam tekrar evine dönen kişide
II.Dünyanın kendi ekseni etrafında dönüşünü tamamlamasında
III.Saatte 70 km.hızla Ankara'dan Adana'ya 5 saatte varan bir otobüste
A) Yalnız I B) Yalnız III C) I ve III D) II ve III

29. Hızın tam olarak bilinmesi için büyüklüğünün yanında başlangıç noktasının,doğrultusunun ve yönünün de belirtilmesi gerekir.
Buna göre hız,aşağıdaki olayların hangisinde tüm özellikleriyle verilmiştir?
A) Araba,saatte 50 km.yol alıyor.
B) Uçak,kuzeyden güneye gidiyor.
C) Araba,Bolu-Ankara karayolunda 90 km/h hızla doğuya doğru gidiyor
D) Boğaz vapuru,Üsküdar'dan Beşiktaş'a 40 km/h hızla gidiyor.

30. Başlangıçta eşit miktarda (5 birim) su bulunan üç ayrı deney düzeneğinde,yaprak sayıları farklı olan aynı türe ait bitkiler konuyor.Bir süre sonra kaplardaki su seviyesinin değişimi aşağıdaki gibi oluyor.

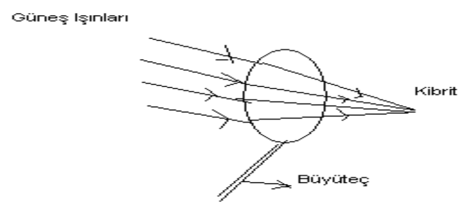


Bu deney düzenekleri;
I.Terleme ile sıcaklık arasındaki ilişkiyi
II.Terleme ile yaprak sayısı arasındaki ilişkiyi
III.Farklı türe ait bitkilerdeki terleme hızını
olaylarından hangilerini araştırmaya yöneliktir?
A)Yalnız I B) Yalnız II C) I ve III D) II ve III

31. Çıplak elle tutularak yünlü kumaşa sürtülen metal çubuğun,küçük kağıt parçalarını çekmemesinin sebebi nedir?
A) Sürtünme ile elektriklenmemesi
B) Kağıt ve metal çubuğun aynı yükle yüklü olması
C) Elektrik yükünü muhafaza edememesi
D) Yünlü kumaşla etkileşmemesi

32. Bir maddenin karışım olup olmadığını anlamak isteyen bir öğrenci,bir kavanoz içerisinde kum,çakıl,pirinç ve tuzu karıştırıyor.Deneyin bu aşamasından sonra öğrencinin hangi soruyu sorması uygun olmaz?
A) Tuz,pirinç,kum ve çakılın özellikleri karıştırılınca değişti mi?
B) Oluşturulan karışımdaki tüm maddeleri karışımdan ayırabilir miyim?
C) Karışımların arı maddelerden farklı olduğu nasıl anlaşılır?
D) Isıtma da karışımları ayırmada kullanılan bir yöntem olduğuna göre bu deney için de uygun yöntem olarak seçilebilir mi?

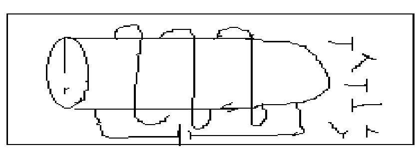
33.



Güneşli bir günde büyüteçle,şekildeki deney yapıldığında tahta parçasının bir süre sonra tutuşup yandığı gözleniyor.
Bu gözlem ile aşağıdakilerden hangisine <u>ulaşılamaz</u>?
A) Enerji dönüştürülebilinir
B) Işık ışınları bir noktada toplanabilir.
C) Işık ışınlarının doğrultuları değiştirilebilinir
D) Maddelerin tutuşma sıcaklıkları aynı olabilir.

34. Kömürle çalışan elektrik santralinde çalışma düzeni,özetle şöyledir:Kömür yakılarak kaynatıcıdaki su,buhara dönüştürülür.Buhar,türibini çevirir,bu da elektrik üretecini çalıştırır,üreteçten alınan elektrik enerjisi evlere gönderilir.
Bu işlemler dizisinde,yararlı enerjinin kömürden başlayarak bir elektrikli ütüde kullanılmasına kadar dönüşümü hangi sırayla olur?
A) Kimyasal---Isı---Hareket---Elektrik---Isı
B) Isı---Kimyasal---Hareket---Isı---Elektrik
C) Isı---Kimyasal---Hareket---Elektrik---Isı
D) Kimyasal---Hareket---Isı---Elektrik---Isı

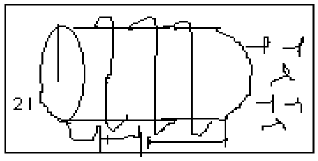
35. Bir bobinden akım geçtiğinde bobin etrafında manyetik alan oluşur ve bobin toplu iğneleri çeker.



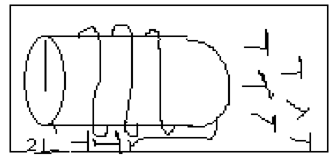
Bir öğrenci, bobinin manyetik alan şiddetinin üzerinden geçen akıma göre değiştiğini,toplu iğnelerin hareketine bakarak göstermek istiyor.

Bunun için yukarıdaki verilen düzenekteki deneye ek olarak aşağıdaki deneylerden hangisini yapmalıdır?

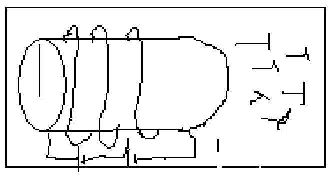
A)



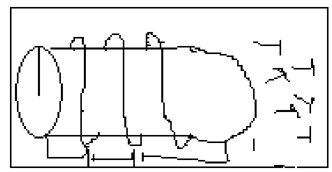
B)



C)



D)



36. Bir cins arı, yüksek sıcaklıkta büyütülürse açık renkli, gelişebileceği en düşük sıcaklıkta büyütülürse siyah renkli olur.
Aşağıdakilerden hangisi bu olayla benzerlik göstermez?
A) Çuha çiçeği bitkisinin 15-20ºC'de kırmızı çiçek açarken 30-35ºC'de beyaz çiçek açması
B) Kuzey Kutbu'na yakın yerlerde yaşayan tavşanların kışın ve yazın farklı renklerde olması
C) Afrika'da yaşayan insanların ten renginin siyah, Avrupa'da yaşayan insanların ten renginin açık olması.
D) Sirke sineklerinin 25ºC'de tutulan larvalarından kıvrık kanatlı yavruların,16ºC'de tutulan larvalarından düz kanatlı yavruların ortaya çıkması

APPENDIX B

Taxonomy of TIMSS

1. Factual Knowledge

   i) Recall or Recognize: Make or identify accurate statements about science facts, relationships, processes, and concepts; identify the characteristics or properties of specific organisms, materials and processes

   ii) Define: Provide or identify definitions of scientific terms; recognize and use scientific vocabulary, symbols, abbreviations, units, and scales in relevant contexts.

   iii) Describe: Recognize or describe organisms, physical materials and science processes that demonstrate knowledge of properties, structure, function and relationships

   iv) Use Tools and Procedures: Demonstrate knowledge of the use of science apparatus, equipment, tools, procedures and measurement devices/scales.

2. Conceptual Understanding

   i) Illustrate with Examples: Support or clarify statements of facts/concepts with appropriate examples; identify or provide specific examples to illustrate knowledge of general concepts.

   ii) Compare/Contrast/Classify: Identify or describe similarities and differences between groups of organisms, materials or processes; distinguish, classify or order individual objects, materials and processes based on characteristics and properties.

   iii) Represent/Model: Use/draw diagrams and/or models to demonstrate understanding of science concepts, structures, relationships, processes, and biological/physical systems and cycles (e.g., food webs, electrical circuits, water cycle, solar system, atomic structure)

   iv) Relate: Relate knowledge of underlying biological and physical concepts to the observed or inferred properties/behaviors/uses of objects, organisms and materials

   v) Extract/Apply Information: Identify/extract/apply relevant textual, tabular or graphical information in light of science concepts/principles.

vi) Find Solutions: Identify/use science relationships, equations, and formulas to find qualitative or quantitative solutions involving the direct application/demonstration of concepts.

vii) Explain: Provide or identify reasons/explanations for observations or natural phenomena, demonstrating understanding of the underlying science concept, principle, law or theory.

3. Reasoning and Analysis

a. Analyze/Interpret/Solve Problems: Analyze problems to determine the relevant relationships, concepts and problem-solving steps; develop/explain problem-solving strategies, interpret/use diagrams and graphics to visualize and/or solve problems, give evidence of deductive and inductive reasoning processes used to solve problems.

b. Integrate/Synthesize: Provide solutions to problems that require consideration of a number of different factors or related concepts; make associations/connections between concepts in different areas of science, demonstrate understanding of unified concepts and themes across the domains of science, integrated mathematical concepts/procedures in the solutions to science problems.

c. Hypothesize/Predict: Combine knowledge of science concepts with information from experience or observation to formulate questions that can be answered by investigation, formulate hypotheses as testable assumptions using knowledge from observation and/or analysis of scientific information and conceptual understanding; make predictions about the effects of changes in biological or physical conditions in light of evidence and scientific understanding.

d. Design/Plan: Design/Plan investigations appropriate for answering scientific questions or testing hypotheses, describe/recognize the characteristics of well-designed investigations in terms of variables to be measured and controlled and cause-effect relationships, make decisions about measurements/procedures to use in conducting investigations.

e. Collect/Analyze/Interpret Data: Make and record systematic observations and measurements, demonstrating appropriate applications of apparatus, equipment, tools, procedures and measurement devices/scales, represent scientific data in tables, charts, graphs and diagrams using appropriate format, labeling and scales, select/apply appropriate mathematical computations/techniques to data to obtain derived values necessary to draw conclusions, detect patterns in data, describe/summarize data trends, and interpolate/extrapolate from data or given information.

f. Draw Conclusions: Make valid inferences on the basis of evidence and/or understanding of science concepts; draw appropriate conclusions that address questions/hypotheses, and demonstrate understanding of cause and effect.

g. Generalize: Make/evaluate general conclusions that go beyond the experimental or given conditions, and apply conclusions to new situations; determine general formulas for expressing physical relationships.

h. Evaluate: Weigh advantages and disadvantages to make decisions about alternative processes, materials and sources, consider scientific factors and social factors to evaluate the impact/consequences of science and technology in biological and physical systems, evaluate alternative explanations and problem-solving strategies and solutions, and evaluate results of investigations with respect to sufficiency of data to support conclusions.

i. Justify: Use evidence and scientific understanding to justify explanations and problem solutions; construct arguments to support the reasonableness of solutions to problems, conclusions from investigations, or scientific explanations.

APPENDIX C

Taxonomy for the Science Process Skills Test

Conceptual Understanding Items	**Reasoning and Analysis Items**
Item 2: Constructing Relationships **Item 3:** Description, Modelling **Item 4:** Description, modeling Item **Item 7:** Explaining **Item 8:** Exemplification **Item 10:** Constructing Relationships **Item 11:** Constructing Relationships **Item 13:** Exemplification **Item 15:** Constructing Relationships **Item 16:** Explaining **Item 21:** Explaining **Item 23:** Exemplification **Item 25:** Exemplification **Item 28:** Explaining **Item 29:** Adaptation of Knowledge **Item 31:** Finding solutions **Item 34:** Comparing/Classifying **Item 36:** Constructing Relationships	**Item 1:**Analysis/Interpreting and Problem Solving **Item 5:** Designing/ Planning **Item 6:** Drawing conclusions **Item 9:** Hypothesis/Estimation **Item 12:** Interpreting Data **Item 14:** Drawing conclusions **Item 17:** Analysis/Interpreting/Problem Solving **Item 18:** Designing/Planning **Item 19:** Drawing conclusions **Item 20:** Problem Solving **Item 22:** Drawing conclusions **Item 24:** Problem Solving **Item 26:** Drawing conclusions **Item 27:** Hypothesis/Estimation **Item 30:** Hypothesis/Estimation **Item 32:** Addition/Analyzing/Interpretation of Data **Item 33:** Analyzing/Interpreting/Problem Solving **Item 35:** Designing/Planning

APPENDIX D
Attitude towards Science Teaching Scale (Fen Öğretimi Tutum Ölçeği)

Aşağıda, Fen Bilgisi öğretmen adaylarının Fen Bilgisi dersinin öğretimine yönelik düşüncelerini belirlemeye yönelik ifadeler bulunmaktadır. Belirtilen ifadelere katılım durumunu 1= Kesinlikle Katılmıyorum'dan 5=Kesinlikle Katılıyorum'a kadar derecelendirilmiş olan rakamlar belirtmektedir. İfadelerin yanındaki 1'den 5'e kadar sıralanmış rakamların yanındaki kutucuklardan size en uygun gelen rakamın yanına (X) işareti koyunuz. Araştırmanın sonuçları, doktora tez çalışmasında kullanılacağından, vereceğiniz yanıtlar, araştırmanın güvenirliği açısından büyük önem taşımaktadır. Katkılarınız için teşekkür ederim.

İlke ÖNAL
ODTÜ Eğitim Fakültesi
Eğitim Bilimleri Bölümü Doktora Öğrencisi

1= **Kesinlikle Katılmıyorum**	2= **Katılmıyorum**	3= **Karasızım**	4= **Katılıyorum**	5= **Kesinlikle Katılıyorum**

		Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1.	Fen öğretirken kendimi rahatsız <u>hissetmem</u>	1❑	2❑	3❑	4❑	5❑
2.	İlköğretim sınıflarında fen dersini öğretmek önemlidir.	1❑	2❑	3❑	4❑	5❑
3.	Feni yeterince <u>öğretemeyeceğimden</u> korkuyorum.	1❑	2❑	3❑	4❑	5❑
4.	Feni öğretmek çok zaman alır.	1❑	2❑	3❑	4❑	5❑
5.	Fen öğretirken laboratuvar çalışmaları ve basit aktiviteler yapmaktan zevk alırım.	1❑	2❑	3❑	4❑	5❑
6.	Feni anlamada zorlanıyorum.	1❑	2❑	3❑	4❑	5❑
7.	İlköğretim programında yer alan fen konularda kendimi rahat hissediyorum.	1❑	2❑	3❑	4❑	5❑
8.	Deneye dayalı fen programında çalışmak ilgimi çekiyor.	1❑	2❑	3❑	4❑	5❑
9.	Fen öğretmek beni endişelendiriyor.	1❑	2❑	3❑	4❑	5❑
10.	Sınıfta fen ile ilgili bir olayı göstermekten <u>korkmuyorum.</u>	1❑	2❑	3❑	4❑	5❑
11.	Sınıfımda fen öğretmek için <u>sabırsızlanmıyorum.</u>	1❑	2❑	3❑	4❑	5❑
12.	Öğrencilerime, fen ile ilgili araç-gereç oluşturmalarında yardımcı olmaktan zevk duyarım.	1❑	2❑	3❑	4❑	5❑
13.	Laboratuvar için gerekli olan araç-gereçleri kurmak için zaman harcamaya istekliyim.	1❑	2❑	3❑	4❑	5❑
14.	Öğrencilerimin cevaplayamayacağım sorular sormalarından korkuyorum.	1❑	2❑	3❑	4❑	5❑
15.	Fen ile ilgili gerekli araç ve gereçlerle uğraşmaktan zevk alırım.	1❑	2❑	3❑	4❑	5❑
16.	Sınıfta fen deneylerinin beklenen sonucu vermemesinden endişe duyarım.	1❑	2❑	3❑	4❑	5❑
17.	Öğrencilerimin fene karşı ilgilerini arttırabileceğimi umuyorum	1❑	2❑	3❑	4❑	5❑
18.	Feni öğretmek çok çaba gerektirir.	1❑	2❑	3❑	4❑	5❑
19.	Çocukların bilimsel olaylar hakkında meraklı olmadığını düşünüyorum.	1❑	2❑	3❑	4❑	5❑
20.	Feni diğer alanlara entegre etmeyi planlıyorum.	1❑	2❑	3❑	4❑	5❑
21.	Fen, okuma, yazma ve dört işlem kadar önemlidir.	1❑	2❑	3❑	4❑	5❑

APPENDIX E

Achievement Test (Başarı Testi)

Aşağıda Özel Öğretim Yöntemleri dersinin tüm kapsamıyla ilgili bilgi, beceri ve genel düşüncelerinizi yoklamaya yönelik 10 tane açık uçlu soru bulunmaktadır. Sizlerden aşağıdaki soruları dikkatlice okuyarak sizlere verilecek olan boş kağıtlar üzerine adınızı soyadınızı yazmanız ve soruları cevaplamanız beklenmektedir. Soruların cevaplanması için sizlere ayrılan süre 1,5 saat (90 dakika) dır. Vereceğiniz yanıtlar doktora tez çalışmasında kullanılacak olup araştırmanın güvenirliği açısından büyük önem taşımaktadır.

Değerli katkılarınız için teşekkür eder, başarılar dilerim.

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1. Yapılandırmacı öğrenme yaklaşımının temel özelliklerini düşündüğünüzde, ilköğretim düzeyinde Fen ve Teknoloji derslerinde öğretme-öğrenme sürecini bu yaklaşıma göre nasıl tasarlarsınız? Hazırlamış olduğunuz öğrenme ortamının özellikleri, öğretmen ve öğrenci rolleri nedir?
2. Fen ve Teknoloji öğretmen adayı olarak Fen ve Teknoloji dersinin temel felsefesi olan yapılandırmacı yaklaşımda ölçme ve değerlendirme sürecinde hangi yaklaşım, yöntem ve teknikleri kullanmalısınız? Gerekçeleriyle kısaca açıklayınız.
3. Fen ve Teknoloji Öğretiminde Probleme Dayalı Öğrenme senaryosu hazırlanırken hangi hususlar göz önünde bulundurulmalıdır? Bir örnek üzerinde açıklayınız.
4. Proje Tabanlı Öğrenme Yaklaşımını uygularken değerlendirmede tercih edeceğiniz ölçme ve değerlendirme yaklaşımları nelerdir? Kullanacağınız araçların özelliklerini kısaca tanımlayınız.
5. Fen ve Teknoloji Öğretiminde sınıf içi ve sınıf dışı etkinlik hazırlanırken izlenmesi gereken yolları listeleyiniz. Bu etkinlikleri hazırlarken dikkat edilmesi gereken hususlar nelerdir?
6. Yaratıcı Drama Yöntemi, Fen ve Teknoloji Öğretimine nasıl entegre edilebilir? Fen ve Teknoloji dersine ilişkin bir örnek üzerinde açıklayınız.
7. Fen ve Teknoloji Eğitiminde etkili kavram öğretimi nasıl sağlanabilir? Örneklerle açıklayınız.
8. Fen ve Teknoloji Eğitiminde sınıf dışı çevre etkinlikleri gerekli midir? Yanıtınızı gerekçeleriyle açıklayınız.
9. Derste öğrencilerinizin dikkatinin dağıldığı anda kullanabileceğiniz ve ilgi çekici olduğunu düşündüğünüz basit bir fen etkinliğini kısaca anlatınız.
10. Yapılandırmacı öğrenme yaklaşımına göre hazırlanmış bir öğrenme süreci sonucunda öğrencilerinizin hangi özellikleri kazanacağını düşünüyorsunuz? Gerekçeleriyle açıklayınız.

APPENDIX F

Table of Specification of the Achievement Test

1. Key concepts of constructivism
2. Properties of constructivist learning environment,teacher and student characteristics.
3. Properties of constructivist measurement and evaluation strategies and their areas of use.
4. The main characteristics of problem-based learning.
5. The key points which should be considered problem-based scenario
6. Properties of measurement and evaluation techniques which are used during Project-based learning process
7. The main steps which should be followed during the preperation of indoor activities.
8. The key points which should be considered during the preperation of indoor activities.
9. The relationship between creative drama and science education.
10. Examples in application of creative drama in science education
11. The main properties of active effective concept learning.
12. The strategies of effecticve concept learning
13. The importance of outdoor activities in science education
14. Planning interesting indoor activities in science
15. The process which the science process skills are gained to the students in science classes.

Skills / Content	Knowledge	Comprehension	Application	Analysis	Synthesis	Critical Thinking Skills	Question Number
1-2	X	X				X	1
3.	X	X				X	2
4-5	X	X	X			X	3
6	X	X				X	4
7-8	X	X	X			X	5
9-10	X	X	X	X	X	X	6
11-12.	X	X	X			X	7
13	X	X	X			X	8
14	X	X	X			X	9
15	X	X	X	X	X	X	10

APPENDIX G
Graded Scoring Key (Rubrics) of Achievement Test

EXPECTED PERFORMANCE DIMENSIONS	PERFORMANCE LEVELS				
QUESTION I	**Not Satisfactory (1)**	**Need to Develop (2)**	**Satisfactory in Middle Level (3)**	**Near to Satisfactory (4)**	**Completely Satisfactory (5)**
Stating the way of organizing constructivist based learning environment (5)	The names of the methods and techniques according to teaching and learning process were stated but the properties of these methods and techniques and also constructivist approach were not stated. Measurement and evaluation process was not explained.	The names of the methods and techniques according to teaching and learning process were stated, some of the properties of these methods were stated but were not made relations with constructivist approach and the properties of constructivist approach were not stated. Measurement and evaluation process was not explained.	The names and properties of methods and techniques were completely stated, the properties of constructivist approach were stated but were not made relations with methods and techniques. Measurement and evaluation process was not explained.	The names and properties of methods and techniques were completely stated, the properties of constructivist approach were stated and made relations with methods and techniques. Measurement and evaluation process was not explained	The names and properties of methods and techniques were completely stated and made relations with constructivist approach. Enough knowledge was given about measurement and evaluation process.
Stating the characteristics of learning environment, the roles of student and teacher in constructivist learning approach (5)	The characteristics of learning environment, the roles of student and teacher were not stated according to constructivist approach	The characteristics of learning environment, the roles of student and teacher were stated but were not made relations with each other and constructivist approach.	The characteristics of learning environment, the roles of student and teacher were stated and the relations of each other were not completely stated and were partially made relations with constructivism.	The characteristics of learning environment, the roles of student and teacher were stated and completely made relations with each other but partially made relations with constructivism.	The characteristics of learning environment, the roles of student and teacher were completely stated and all dimensions related with constructivism were explained in a detailed manner.

APPENDIX G
Graded Scoring Key (Rubrics) of Achievement Test

EXPECTED PERFORMANCE DIMENSIONS	PERFORMANCE LEVELS				
QUESTION II	**Not Satisfactory (1)**	**Need to Develop (2)**	**Satisfactory in Middle Level (3)**	**Near to Satisfactory (4)**	**Completely Satisfactory (5)**
Stating the measurement and evaluation process in constructivist approach (5)	Organization process according to constructivist approach were not stated. Relationship between organization process and measurement and evaluation process were not made.	Organization process according to constructivist approach were partially stated but the names and properties of methods and techniques were not stated. Relationship between organization process and measurement and evaluation process were not made. .	Organization process according to constructivist approach were stated, the names of the methods and techniques were completely stated but the properties of them were not explained. Relationship between organization process and measurement and evaluation process were not made. .	Organization process according to constructivist approach were stated, the names and properties of the methods and techniques were completely stated. Relationship between organization process and measurement and evaluation process were not completely made with all dimensions.	Organization process according to constructivist approach were stated, the names and properties of the methods and techniques were completely stated. Relationship between organization process and measurement and evaluation process were completely made with all dimensions.

APPENDIX G
Graded Scoring Key (Rubrics) of Achievement Test

EXPECTED PERFORMANCE DIMENSIONS	PERFORMANCE LEVELS				
QUESTION III	**Not Satisfactory (1)**	**Need to Develop (2)**	**Satisfactory in Middle Level (3)**	**Near to Satisfactory (4)**	**Completely Satisfactory (5)**
Stating the definition of problem based learning scenario and its properties (5)	The definition of problem-based learning scenario and its properties were not stated.	The definition of problem-based learning scenario was partially stated but were not made relations with problem-based learning approach. The properties of problem-based learning scenario were not explained..	The definition of problem-based learning scenario was partially stated and made relations with problem-based learning approach. The properties of problem-based learning scenario were not explained.	The definition of problem-based learning scenario was partially stated and made relations with problem-based learning approach. The properties of problem-based learning scenario were partially explained.	The definition of problem-based learning scenario was partially stated and made relations with problem-based learning approach. The properties of problem-based learning scenario were completely explained with all dimensions.
Constructing a sample problem-based learning scenario (5)	The problem statement which can be constructed as a problem-based learning scenario was not stated.	The problem statement which can be constructed as a problem-based learning scenario was stated but critical questions and instructions related to the problem statement were not constructed. .	The problem statement which can be constructed as a problem-based learning scenario was stated and instructions were given but critical questions related to the problem statement were not constructed.	The problem statement which can be constructed as a problem-based learning scenario was stated and instructions were given, critical questions related to the problem statement were partially constructed.	The problem statement which can be constructed as a problem-based learning scenario was stated and instructions were given, critical questions which covered all problem statement were completely given.

APPENDIX G
Graded Scoring Key (Rubrics) of Achievement Test

EXPECTED PERFORMANCE DIMENSIONS	PERFORMANCE LEVELS				
QUESTION IV	**Not Satisfactory (1)**	**Need to Develop (2)**	**Satisfactory in Middle Level (3)**	**Near to Satisfactory (4)**	**Completely Satisfactory (5)**
Conceptualize the properties of project based learning approach and the properties of measurement and evaluation tools according to this approach (10)	Don't state the properties of project based learning approach and the properties of measurement and evaluation tools according to this approach	State the properties of project based learning approach partially and don't explain the properties of measurement and evaluation tools according to this approach .	State the properties of project based learning approach partially and state the names of measurement and evaluation tools but don't explain their properties according to this approach	State the properties of project based learning approach partially and state the names of measurement and evaluation tools but explain their properties according to this approach partially.	State the properties of project based learning approach partially and state the names of measurement and evaluation tools and explain their properties according to this approach completely.

APPENDIX G
Graded Scoring Key (Rubrics) of Achievement Test

EXPECTED PERFORMANCE DIMENSIONS	PERFORMANCE LEVELS				
QUESTION V	**Not Satisfactory (1)**	**Need to Develop (2)**	**Satisfactory in Middle Level (3)**	**Near to Satisfactory (4)**	**Completely Satisfactory (5)**
Listing the ways when preparing indoor activities and explaining the points considered during this process (5)	Don't list the ways when preparing indoor activities and don't explain the points considered during this process.	The definition of problem-based learning scenario was partially stated but were not made relations with problem-based learning approach. The properties of problem-based learning scenario were not explai	List the ways when preparing indoor activities partially and explain the points considered during this process but don't relate them with activity preparation steps.	List the ways when preparing indoor activities partially and explain the points considered during this process and relate them with activity preparation steps partially.	List the ways when preparing indoor activities partially and explain the points considered during this process and relate them with activity preparation steps completely.
Listing the ways when preparing outdoor activities and explaining the points considered during this process (5)	Don't list the ways when preparing outdoor activities and don't explain the points considered during this process.	List the ways when preparing outdoor activities partially but don't explain the points considered during this process.	List the ways when preparing outdoor activities partially and explain the points considered during this process but don't relate them with activity preparation steps.	List the ways when preparing outdoor activities partially and explain the points considered during this process and relate them with activity preparation steps partially.	List the ways when preparing outdoor activities partially and explain the points considered during this process and relate them with activity preparation steps completely.

APPENDIX G
Graded Scoring Key (Rubrics) of Achievement Test

EXPECTED PERFORMANCE DIMENSIONS	PERFORMANCE LEVELS				
QUESTION VI	**Not Satisfactory (1)**	**Need to Develop (2)**	**Satisfactory in Middle Level (3)**	**Near to Satisfactory (4)**	**Completely Satisfactory (5)**
Explain what creative drama is, their properties and their relationship with science education (5)	Don't explain what creative drama is, their properties and their relationship with science education	State what creative drama is partially but don't explain their properties and their relationship with science education.	State what creative drama is and explain their properties partially but don't explain their relationship with science education.	State what creative drama is and explain their properties partially but explain their relationship with science education partially.	State what creative drama is and explain their properties partially and explain their relationship with science education completely.
Preparing creative drama session according to science topics (5)	Don't state the purpose, aims, introduction, development and conclusion parts of creative drama session.	State the purpose and aims of creative drama session but don't explain introduction, development and conclusion parts of creative drama session.	State the purpose and aims of creative drama session and explain introduction, development and conclusion parts but don't relate aims and the parts of creative drama session.	State the purpose and aims of creative drama session and explain introduction, development and conclusion parts and also relate aims and the parts of creative drama session but don't state the implications about science education.	State the purpose and aims of creative drama session and explain introduction, development and conclusion parts and also relate aims and the parts of creative drama session and state the implications about science education completely.

APPENDIX G
Graded Scoring Key (Rubrics) of Achievement Test

EXPECTED PERFORMANCE DIMENSIONS	PERFORMANCE LEVELS				
QUESTION VII	**Not Satisfactory (1)**	**Need to Develop (2)**	**Satisfactory in Middle Level (3)**	**Near to Satisfactory (4)**	**Completely Satisfactory (5)**
Explain misconceptions in Science and Technology education and their sources, effective concept teaching methodologies and give examples from science. (10)	Don't explain misconceptions in Science and Technology education and their sources, effective concept teaching methodologies and don't give examples from science.	Explain the definitions of misconceptions in Science and Technology education but don't state their sources and effective concept teaching methodologies and don't give examples from science.	Explain the definitions of misconceptions in Science and Technology education,state their sources but don't explain effective concept teaching methodologies and don't give examples from science.	Explain the definitions of misconceptions in Science and Technology education,state their sources and explain effective concept teaching methodologies but don't give examples from science.	Explain the definitions of misconceptions in Science and Technology education,state their sources explain effective concept teaching methodologies and also give concrete examples from science.
QUESTION VIII					
Explain what the outdoor activities are and their importance in science education with examples (10)	Explain what the outdoor activities are and their properties	Explain what the outdoor activities are but don't state their general characteristics and their importance in science education	Explain what the outdoor activities and their general characteristics but don't state their importance in science education	Explain what the outdoor activities and their general characteristics state their importance in science education but don't support them with examples	Explain what the outdoor activities and their general characteristics state their importance in science education and support them with examples

APPENDIX G
Graded Scoring Key (Rubrics) of Achievement Test

EXPECTED PERFORMANCE DIMENSIONS	PERFORMANCE LEVELS				
QUESTION IX	**Not Satisfactory (1)**	**Need to Develop (2)**	**Satisfactory in Middle Level (3)**	**Near to Satisfactory (4)**	**Completely Satisfactory (5)**
Organizing an interesting science activity when the students' attentions were gone off (10)	Not organize an activity when the students' attentions were gone off.	Organize an activity when the students' attentions were gone off but don't state necessary instructions and application steps and don't relate them with science.	Organize an activity when the students' attentions were gone off, state necessary instructions but don't state application steps and don't relate them with science.	Organize an activity when the students' attentions were gone off, state necessary instructions and application steps but don't relate them with science.	Organize an activity when the students' attentions were gone off, state necessary instructions and application steps and also relate them with science.
QUESTION IX					
Explain which properties students gain after constructivist learning environments and gave their reasons (10)	Don't state names and properties of skills which can be gained after constructivist learning environments and say their reasons	Organize an activity when the students' attentions were gone off but don't state necessary instructions and application steps and don't relate them with science.	State names and properties of skills which can be gained after constructivist learning environments but don't say their reasons	State names and properties of skills which can be gained after constructivist learning environments but say their reasons partially	State names and properties of skills which can be gained after constructivist learning environments and say their reasons completely .

APPENDIX H

Presentation Observation Form (Sunuş Gözlem Formu)

Both instructor and the groups which listen the presenter group will fill this form.

The criteria and performance scale about the presentation which the groups make are given below. Please fill in the parts below and put (X) on the related parts of the form.

Course Code and Name:

The unit and topic:

Estimated time for presentation:

Please describe the general seating of the class
(For example, draw a picture about class size, general description, class position, teachers' table, students' chairs and tables' position…etc.)

Materials in the class (Please write their positions of the materials in class)

Video:

Computer:

Data projector:

Other materials
…………………

Introductory Activities:
Please describe the introductory activities of the instructor, for example;

Activities which are done during the first 10 minutes

Teachers' voice:

Students' voices and their participation:

Critical Questions:

Other Activities:
……………………

Approaches, Methods and Techniques Used in the Class by Instructor (In what level and for which purpose)

	Never	Rarely	Seldom	Usually	Always
Discovery Learning					
Question-Answer					
Brain Storming					
Presentation					
Project Based Learning					
Problem Based Learning					
Concept Mapping					
Other					

Materials Used by Instructor in the Class (In what level and for which purpose)

	Never	Rarely	Seldom	Usually	Always
Slayt					
Data Projector					
Computer					
Video camera					
Music player					
Photographs					
Overhead projector					
Blackboard					
Books					
Other materials					

Assessment Approaches, Methods, Techniques and Materials Used In the Class (In what level and for which purpose)

	Never	Rarely	Seldom	Usually	Always
Portfolio Assessment					
Performance-Based Assessment					
Self-evaluation					
Checklists					
Rubrics					
Quiz					
Midterm					

Please emphasize the strengths of the presentation

………
………
………
………………………………………………………………………..

Please emphasize the parts that need to be improved in the presentation

………
………
………
……………………………………………………………………….

Please give a score from 1=poor to 5=excellent for in what level the lesson which the group presented is constructivist. Please write your reasons about why you give this score

………
………
………
………………………………………………………………………...

If any, please write your additional comments

………
………
………
………………………………………………………………………..

APPENDIX I

Group Assessment Form (Grup Değerlendirme Formu)

Aşağıda grup çalışmalarınız hakkında grup üyelerinize yönelik 1=Hiçbir Zaman'dan 5= Her Zaman'a kadar derecelendirilmiş ifadeler göreceksiniz. İfadelerin yanındaki 1'den 5'e kadar sıralanmış rakamların yanındaki kutucuklardan size en uygun gelen rakamın yanına (X) işareti koyunuz. Katkılarınız için teşekkür ederim.

İlke ÖNAL

ODTÜ Eğitim Fakültesi Eğitim Bilimleri Bölümü Doktora Öğrencisi

1= Hiçbir Zaman	2= Nadiren	3= Arasıra	4= Genellikle	5= Herzaman

	Hiçbir Zaman	Nadiren	Ara sıra	Genellikle	Her zaman
1. Gruptaki her üye eşit derecede görev aldı.	1❑	2❑	3❑	4❑	5❑
2. Grup üyeleri birbirleriyle yardımlaştı.	1❑	2❑	3❑	4❑	5❑
3. Grup üyeleri birbirlerinin düşüncelerine saygı gösterdi	1❑	2❑	3❑	4❑	5❑
4. Grup üyeleri, sunum sırasında eşit ve aktif katılım sağladı.	1❑	2❑	3❑	4❑	5❑
5. Grup üyeleri bireysel olarak bulduklarını grupla paylaştı.	1❑	2❑	3❑	4❑	5❑
6. Grup üyeleri çalışma takvimi oluşturdu.	1❑	2❑	3❑	4❑	5❑
7. Grup üyeleri belirledikleri çalışma takvimine uydu.	1❑	2❑	3❑	4❑	5❑
8. Grup üyeleri bireysel sorumluluklarını yerine getirdi.	1❑	2❑	3❑	4❑	5❑
9. Grupta farklı görüşler oluştuğunda bu görüşler, demokratik ortamda tartışıldı.	1❑	2❑	3❑	4❑	5❑
10. Gruptaki her kişi bir diğerinin öğrenmesinden sorumlu oldu.	1❑	2❑	3❑	4❑	5❑
11. Grup üyeleri birbirlerini cesaretlendirdi.	1❑	2❑	3❑	4❑	5❑
12. Grup üyeleri sunumu hazırlarken farklı kaynaklardan yararlandı.	1❑	2❑	3❑	4❑	5❑
13. Grup üyeleri sunum sırasında öğrenci merkezli farklı öğretim yöntem ve tekniklerini kullandı.	1❑	2❑	3❑	4❑	5❑
14. Grup üyeleri,sınıfla etkileşimi sağlayacak etkinlikler hazırlamaya önem verdi.	1❑	2❑	3❑	4❑	5❑
15. Grup üyeleri yapılandırmacı anlayışa uygun bir ders tasarladı.	1❑	2❑	3❑	4❑	5❑
16. Grup üyeleri yapılandırmacı anlayışa uygun bir sunum yaptı.	1❑	2❑	3❑	4❑	5❑
17. Grup üyeleri öğrenci merkezli ölçme ve değerlendirme yöntemlerini kullandı.	1❑	2❑	3❑	4❑	5❑

APPENDIX J

Self Assessment Form (Bireysel Değerlendirme Formu)

Aşağıda bireysel çalışmalarınız hakkında kendinize yönelik 1=Hiçbir Zaman'dan 5= Her Zaman'a kadar derecelendirilmiş ifadeler göreceksiniz. İfadelerin yanındaki 1'den 5'e kadar sıralanmış rakamların yanındaki kutucuklardan size en uygun gelen rakamın yanına (X) işareti koyunuz Katkılarınız için teşekkür ederim.

İlke ÖNAL
ODTÜ Eğitim Fakültesi Eğitim Bilimleri Bölümü Doktora Öğrencisi

1= Hiçbir Zaman	2= Nadiren	3= Arasıra	4= Genellikle	5= Herzaman

	Hiçbir Zaman	Nadiren	Ara sıra	Genellikle	Her zaman
1. Çalışmalarım için bir çalışma takvimi oluşturdum.	1❑	2❑	3❑	4❑	5❑
2. Çalışmalarım sırasında belirlediğim çalışma takvimine uydum.	1❑	2❑	3❑	4❑	5❑
3. Çalışmalarım sırasında farklı kaynaklardan yararlanmaya özen gösterdim.	1❑	2❑	3❑	4❑	5❑
4. Tüm çalışma boyunca grupla uyum içindeydim.	1❑	2❑	3❑	4❑	5❑
5. Bulduğum bilgi ve fikirleri grubumla paylaştım.	1❑	2❑	3❑	4❑	5❑
6. Grup arkadaşlarımın fikir ve çabalarına saygı gösterdim.	1❑	2❑	3❑	4❑	5❑
7. Grup içinde bireysel sorumluluklarımı yerine getirdim.	1❑	2❑	3❑	4❑	5❑
8. Grup içerisinde diğer arkadaşlarımın öğrenmelerinden sorumlu idim.	1❑	2❑	3❑	4❑	5❑
9. Gruptaki arkadaşlarımı yüreklendirmede aktif rol oynadım.	1❑	2❑	3❑	4❑	5❑
10. Sunum sırasında öğrenci merkezli öğretim yöntem ve tekniklerinden yararlandım.	1❑	2❑	3❑	4❑	5❑
11. Sunum sırasında sınıfla etkileşim kurmaya özen gösterdim.	1❑	2❑	3❑	4❑	5❑
12. Yapılandırmacı anlayışa uygun bir ders planı hazırladım.	1❑	2❑	3❑	4❑	5❑
13. Yapılandırmacı anlayışa uygun ölçme ve değerlendirme yöntemlerini kullandım.	1❑	2❑	3❑	4❑	5❑
14. Grup üyeleriyle çalışmaktan zevk aldım.	1❑	2❑	3❑	4❑	5❑
Eklemek istediklerim:					

APPENDIX K

Presentation Observation, Group Assessment and Self Assessment Form Results

Throughout the treatment, the researcher was the instructor for both the experimental and control groups during the whole process for ensuring that in the experimental group only the constructivist based instruction lesson plans and in the control groups only the traditional method were used. Presentation Observation Form consists of general setting of the class, materials in the class, introductory activities, learning and teaching approaches, methods and techniques used in the class by the instructor, materials used by instructor in class, assessment approaches, methods and techniques which were used in class, strenghts of the presentation, the parts that need to be improved in the presentation, giving a score in what level the presentation is constructivist and their reasons and additional comments. A total of 30 observations (15 experimental and 15 control groups) were made by one researcher from science education field for 15 weeks and also the instructor of the course and total of 10 observations (5 experimental and 5 control) were made by a researcher from science education field for five weeks for providing treatment verification of the study. The results of the presentation observation forms were given below. General setting and materials in the class were the same for both experimental and control groups. For explaining introductory activity properties were given in Table 1

Table 1

Introductory Activities

	Experimental Group's Percentages	Control Group's Percentages
Teacher used prior learnings of students	93.3 %	13.3%
Teacher gives reinforcement to the students	100%	20%
Teacher encourages students for group working	100%	26.6%

According to these results, instructor in experimental group mostly used students' prior learnings, she gave reinforcement to the students and encouraged them for group working. It could be said that she rarely showed these characteristics in the control group by looking at the table. The properties of learning and teaching approaches, methods and techniques used in class by the instructor were shown in Table 2

Table 2

The Teaching and Learning Approaches, Methods and Techniques Used In the Class by Instructor

	Experimental Group's Percentages					Control Group's Percentages				
	Never	Rarely	Seldom	Usually	Always	Never	Rarely	Seldom	Usually	Always
Discovery Learning					86.6%	73.3%	26.6%			
Question-Answer					100%				73.3%	
Brain Storming				80%		86.6%				
Presentation	20%	80%								100%
Project Based Learning				86.6%		86.6%				
Problem Based Learning				86.6%		86.6%				
Concept Mapping				93.3%				73.3%		
Other										

According to Table 2, it could be said that student centered teaching and learning approaches, methods and techniuques which are discovery learning, brainstorming, project based learning, problem based learning were always and usually used in experimental group and never and rarely used in control group. Presentation method was rarely and never used in experimental group and always used in control group. Question-answer technique was usually and always used in both experimental and control group.

Materials used by instructor in the class were shown in Table 3

Table 3

Materials Used by the Instructor in Class

	Experimental Group's Percentages					Control Group's Percentages				
	Never	Rarely	Seldom	Usually	Always	Never	Rarely	Seldom	Usually	Always
Slides		86.6%								86.6%
Data Projector				73.3%	26.6%				86.6%	
Computer				73.3%	26.6%					86.6%
Video camera				66.6%						
Music player			26.6%							
Photographs				66.6%						
Overhead projector				73.3%						
Blackboard										
Books										
Other Materials			66.6%							

It can be said that only computers and slides were usually and always used in control group but in experimental group multiple materials were used by the instructor according to Table 3. In "other materials" section; observers claimed educational plays such as tangrams, demonstrations related to topic in experimental group.

Assessment approaches, methods and techniques which were used in class by the instructor were given in Table 4

Table 4

Assessment Approaches, Methods and Techniques Which Were Used in Class By Instructor

	Experimental Group's Percentages					Control Group's Percentages				
	Never	Rarely	Seldom	Usually	Always	Never	Rarely	Seldom	Usually	Always
Portfolio Assessment				73.3%			73.3%			
Performance - Based Assessment					100%		86.6%			
Self-evaluation					100%	100%				
Checklists					100%	100%				
Rubrics				100%						
Quiz										
Midterm										

According to Table 4, student-centered measurement and evaluation approaches such as portfolio assessment, performance based assessment, self evaluation forms and observation checklists were usually and always used in experimental group and never and rarely used in control group. Observers didn't check anything about quiz and midterm choices.

The mean of the experimental group for indicating the appropriateness of instruction according to constructivist approach (from 1 to 5) was found as 4.86 and the mean of the control group for indicating the appropriateness of instruction according to constructivist approach (from 1 to 5) was found as 1.86

Presentation observation forms were used also during the presentation of the groups in experimental group for providing objectivity and having other participants to participate the presentation process. There were 14 groups in both experimental and control groups. Each group had three or four participant. All groups filled out the group assessment forms and self assessment forms after their presentation. Presentation Observation Forms were filled out by instructor, observers and other audience groups. Strong relationship was found with self assessment form grades and achievement which was .89, group assessment forms and self assessment forms which was .94, presentation observation forms which were filled out by the groups and the instructor which was .91. These correlations show that the expectations about the constructivist approach was understood by all the participants in experimental group and the objectivity of the measurement and evaluation process was high and valid.

APPENDIX L

Questionnaire (Anket)

Bu görüşmede Özel Öğretim Yöntemleri dersi ve Fen Bilgisi Öğretimine ilişkin görüşlerinizi saptamaya yönelik sorular bulunmaktadır. Vereceğiniz cevaplardan ulaşılacak sonuçlar sadece yapmış olduğum araştırma kapsamında isim belirtmeksizin kullanılacaktır. Lütfen aşağıda verilen soruların yanıtlarını ipucu sorularıyla birlikte ele alarak size verilen boş kağıtlar üzerinde yanıtlayınız. Değerli katkılarınız için teşekkür ederim.

İlke ÖNAL
ODTÜ Eğitim Fakültesi Eğitim Bilimleri Bölümü Doktora Öğrencisi

1. Fen öğretimi konusunda kendinizi nasıl değerlendiriyorsunuz?

Alternatif Soru 1: Fen ve Teknoloji derslerini öğretme konusunda kendinizi eksik hissettiğiniz noktalar var mıdır? Varsa nelerdir?

İpucu 2: Fen ve Teknoloji derslerinde kendinizi iyi hissettiğiniz noktalar var mıdır? Varsa nelerdir?

2. Fen öğretiminde en çok tercih ettiğiniz/edeceğiniz yöntem ve teknikler nelerdir? Bu yöntem ve teknikleri seçme nedenlerinizi açıklar mısınız?

Alternatif Soru 1: Fen öğretiminde sizce hangi yöntem ve teknikler öğrenciler üzerinde en etkili öğrenmeyi sağlayacaktır? Görüşünüze destek olacak gerekçeler belirtir misiniz?

3. Alanında başarıya ulaşmış bir Fen Bilgisi öğretmenini tanımlar mısınız?

Alternatif Soru 1: Sizce başarılı bir Fen Bilgisi öğretmeninin özellikleri nelerdir?

4. Özel Öğretim Yöntemleri dersinin Fen öğretimindeki yeri sizce nedir?

Alternatif Soru 1: Özel Öğretim Yöntemleri dersinin fen öğretiminde önem teşkil ettiğine inanıyor musunuz? Nedenlerini açıklar mısınız?

5. Etkili bir fen öğretiminin sağlanması için Özel Öğretim Yöntemleri dersinde geliştirilmesi gereken yönler sizce nelerdir?

Alternatif Soru 1: Öğretmen adaylarının fen öğretimi becerilerinin geliştirilmesi için Özel Öğretim Yöntemleri dersi sizce nasıl düzenlenmelidir?

6. Özel Öğretim Yöntemleri dersi sonunda fen öğretimi konusunda kendinizi nasıl hissedeceğinizi düşünüyorsunuz? Başından sonuna kadar Özel Öğretim Yöntemleri dersi

sürecini gözden geçirdiğinizde; öğretim programına hakimiyet, öğretim yöntem ve teknikleriyle ölçme ve değerlendirme yöntem ve tekniklerini kullanma konusunda kendinizi hangi yönlerde geliştireceğinizi düşünüyorsunuz?

Alternatif Soru 1: Özel Öğretim Yöntemleri dersi sonunda hangi tür bilgi ve becerileri kazanacağınızı düşünüyorsunuz? Bu becerilere hangi süreçler sonucunda ulaşacaksınız? Örneklerle açıklar mısınız?-Süreç başında

7. Özel Öğretim Yöntemleri dersi sonunda fen öğretimi konusunda kendinizi nasıl hissediyorsunuz? Başından sonuna kadar Özel Öğretim Yöntemleri dersi sürecini gözden geçirdiğinizde; öğretim programına hakimiyet, öğretim yöntem ve teknikleriyle ölçme ve değerlendirme yöntem ve tekniklerini kullanma konusunda kendinizi hangi yönlerde geliştirdiğinizi düşünüyorsunuz?

Alternatif Soru 1: Özel Öğretim Yöntemleri dersi sonunda hangi tür bilgi ve becerileri kazandığınızı düşünüyorsunuz? Bu becerilere hangi süreçler sonucunda ulaştınız? Örneklerle açıklar mısınız?-Süreç sonunda

APPENDIX M

Formative Interview Questions (Uygulama Sırası Görüşme Soruları)

Merhaba Arkadaşlar;

Bu görüşmenin amacı Özel Öğretim Yöntemleri dersi ve Fen Bilgisi Öğretimine ilişkin algılarınızı ve görüşlerinizi saptamaktır. Görüşmemiz yaklaşık 30-40 dakika sürecektir.Vereceğiniz cevaplardan ulaşılacak sonuçlar sadece yapmış olduğum araştırma kapsamında isim belirtmeksizin kullanılacaktır. İzin verirseniz önemli detayları kaçırmamak için görüşmeyi kayıt etmek istiyorum. Görüşme kayıtları yalnızca bu araştırma kapsamında kullanılacaktır. Bu görüşmeyi onaylıyor musunuz? Onaylıyorsanız görüşmeyi başlatmak istiyorum. Bu arada sormak istediğiniz tüm soruları cevaplamaya hazırım. Değerli katkılarınız için teşekkür ederim.

İlke ÖNAL
ODTÜ Eğitim Fakültesi Eğitim Bilimleri Bölümü Doktora Öğrencisi

1. Fen öğretimi konusunda kendinizi nasıl değerlendiriyorsunuz?

Alternatif Soru 1: Fen ve Teknoloji derslerini öğretme konusunda kendinizi eksik hissettiğiniz noktalar var mıdır? Varsa nelerdir?

Alternatif Soru 2: Fen ve Teknoloji derslerinde kendinizi iyi hissettiğiniz noktalar var mıdır? Varsa nelerdir?

2. Fen öğretiminde en çok tercih ettiğiniz/edeceğiniz yöntem ve teknikler nelerdir? Bu yöntem ve teknikleri seçme nedenlerinizi açıklar mısınız?

Alternatif Soru 1: Fen öğretiminde sizce hangi yöntem ve teknikler öğrenciler üzerinde en etkili öğrenmeyi sağlayacaktır? Görüşünüze destek olacak gerekçeler belirtir misiniz?

3. Alanında başarıya ulaşmış bir Fen Bilgisi öğretmenini tanımlar mısınız?

Alternatif Soru 1: Sizce başarılı bir Fen Bilgisi öğretmeninin özellikleri nelerdir?

4. Alanında başarılı bir Fen öğretmeni olabilmek için Özel Öğretim Yöntemleri II dersinin etkisi var mıdır? Varsa nadir? Örneklerle açıklar mısınız?

5. Özel Öğretim Yöntemleri dersinin Fen öğretimindeki yeri sizce nedir?

Alternatif Soru 1: Özel Öğretim Yöntemleri dersinin fen öğretiminde önem teşkil ettiğine inanıyor musunuz? Nedenlerini açıklar mısınız?

6. Etkili bir fen öğretiminin sağlanması için Özel Öğretim Yöntemleri dersinde geliştirilmesi gereken yönler sizce nelerdir?

Alternatif Soru 1: Öğretmen adaylarının fen öğretimi becerilerinin geliştirilmesi için Özel Öğretim Yöntemleri dersi sizce nasıl düzenlenmelidir?

7. Özel Öğretim Yöntemleri II dersiyle yapılandırmacı yaklaşım arasında bir ilişki görüyor musunuz? Örneklerle açıklar mısınız?

8. Özel Öğretim Yöntemleri II dersinizin yapılandırmacı anlayışa uygun olarak işlendiğini düşünüyor musunuz? Cevabınız doğrultusunda hangi yönlerden yapılandırmacı yaklaşıma uygun olduğunu ya da olmadığını örneklerle açıklar mısınız?

9. Özel Öğretim Yöntemleri II dersini oluşturmacı yaklaşım uygun hale getirmek için neler yapılabileceğini düşünüyorsunuz? Örneklerle açıklar mısınız?

10. Özel Öğretim Yöntemleri dersi sonunda fen öğretimi konusunda kendinizi nasıl hissedeceğinizi düşünüyorsunuz? Başından sonuna kadar Özel Öğretim Yöntemleri dersi sürecini gözden geçirdiğinizde; öğretim programına hakimiyet, öğretim yöntem ve teknikleriyle ölçme ve değerlendirme yöntem ve tekniklerini kullanma konusunda kendinizi hangi yönlerde geliştireceğinizi düşünüyorsunuz?

Alternatif Soru 1: Özel Öğretim Yöntemleri dersi sonunda hangi tür bilgi ve becerileri kazanacağınızı düşünüyorsunuz? Bu becerilere hangi süreçler sonucunda ulaşacaksınız? Örneklerle açıklar mısınız?

APPENDIX N

Summative Interview Questions (Uygulama Sonrası Görüşme Soruları)

Merhaba Arkadaşlar;

Bu görüşmenin amacı Özel Öğretim Yöntemleri dersi ve Fen Bilgisi Öğretimine ilişkin algılarınızı ve görüşlerinizi saptamaktır. Görüşmemiz yaklaşık 30-40 dakika sürecektir.Vereceğiniz cevaplardan ulaşılacak sonuçlar sadece yapmış olduğum araştırma kapsamında isim belirtmeksizin kullanılacaktır. İzin verirseniz önemli detayları kaçırmamak için görüşmeyi kayıt etmek istiyorum. Görüşme kayıtları yalnızca bu araştırma kapsamında kullanılacaktır. Bu görüşmeyi onaylıyor musunuz? Onaylıyorsanız görüşmeyi başlatmak istiyorum. Bu arada sormak istediğiniz tüm soruları cevaplamaya hazırım. Değerli katkılarınız için teşekkür ederim.

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ODTÜ Eğitim Fakültesi Eğitim Bilimleri Bölümü Doktora Öğrencisi

1. Fen öğretimi konusunda kendinizi nasıl değerlendiriyorsunuz?

Alternatif Soru 1: Fen ve Teknoloji derslerini öğretme konusunda kendinizi eksik hissettiğiniz noktalar var mıdır? Varsa nelerdir?

Alternatif Soru 2: Fen ve Teknoloji derslerinde kendinizi iyi hissettiğiniz noktalar var mıdır? Varsa nelerdir?

2. Fen öğretiminde en çok tercih ettiğiniz/edeceğiniz yöntem ve teknikler nelerdir? Bu yöntem ve teknikleri seçme nedenlerinizi açıklar mısınız?

Alternatif Soru 1: Fen öğretiminde sizce hangi yöntem ve teknikler öğrenciler üzerinde en etkili öğrenmeyi sağlayacaktır? Görüşünüze destek olacak gerekçeler belirtir misiniz?

3. Alanında başarıya ulaşmış bir Fen Bilgisi öğretmenini tanımlar mısınız?

Alternatif Soru 1: Sizce başarılı bir Fen Bilgisi öğretmeninin özellikleri nelerdir?

4. Fen öğretmenlerinin hangi sebeplerle kendilerini geliştirmediklerini düşünüyorsunuz? Örneklerle açıklar mısınız?

5. Başarılı fen öğretmenleri olmada genel öğretim derslerinin etkisi olduğunu düşünüyor musunuz? Cevabınız için gerekçeler sunar mısınız?

6. Özel Öğretim Yöntemleri dersinin Fen öğretimindeki yeri sizce nedir?

Alternatif Soru 1: Özel Öğretim Yöntemleri dersinin fen öğretiminde önem teşkil ettiğine inanıyor musunuz? Nedenlerini açıklar mısınız?

7. Etkili bir fen öğretiminin sağlanması için Özel Öğretim Yöntemleri dersinde geliştirilmesi gereken yönler sizce nelerdir?
Alternatif Soru 1: Öğretmen adaylarının fen öğretimi becerilerinin geliştirilmesi için Özel Öğretim Yöntemleri dersi sizce nasıl düzenlenmelidir?

8. Özel Öğretim Yöntemleri II dersiyle oluşturmacı yaklaşım arasında bir ilişki görüyor musunuz? Cevabınızı gerekçeleriyle açıklar mısınız?

9. Özel Öğretim Yöntemleri II dersini oluşturmacı yaklaşıma uygun hale getirmek için değiştirilmesi veya geliştirilmesi gereken yönler nelerdir? Örneklerle açıklar mısınız?

10. Özel Öğretim Yöntemleri dersi sonunda fen öğretimi konusunda kendinizi nasıl hissediyorsunuz? Başından sonuna kadar Özel Öğretim Yöntemleri dersi sürecini gözden geçirdiğinizde; öğretim programına hakimiyet, öğretim yöntem ve teknikleriyle ölçme ve değerlendirme yöntem ve tekniklerini kullanma konusunda kendinizi hangi yönlerde geliştirdiğinizi düşünüyorsunuz?
Alternatif Soru 1: Özel Öğretim Yöntemleri dersi sonunda hangi tür bilgi ve becerileri kazandığınızı düşünüyorsunuz? Bu becerilere hangi süreçler sonucunda ulaştınız? Örneklerle açıklar mısınız?

APPENDIX O

Questionnaire Category And Codes

Table 1

Areas of Strength and Weakness

Experimental Group		Control Group	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
*Using methods and techniques which were learned before not effectively (34)	* Identfying in Which Topics Students Can Constrain (11)	*Constructivism (21)	*Unit of Solar System and Space (8)
*Content Area (36)	*Content of the Science and Technology course (24)	*The Knowledge of Content (32)	*The Effect of Application of the Program to the Preservice Teachers (32)
*See her or himself in middle level (19)	*Theoretical Knowledge (24)	*Creative Drama (33)	*The Lack of Astronomy Course (9)
*Concept Teaching (25)	*In What Amount and What to Give Students (19)	*Question-Answer (19)	*Gaps in Classroom Management (30)
*Time Organizing (22)	*Telling Course Without Making Preperation (12)	*Brain Storming (13)	*Processing Course Theoretically and Individually (31)
*Application (36)	*Topics Related to Chemistry (9)	*Six Thinking Hats Technique (13)	*Process-Based Assessment Approaches (29)
*Laboratuary (27)	*Content Knowledge (20)	*Space and Astronomy (8)	*Dimension of Application (35)
*Curriculum (25)		*Classroom Management (31)	*Knowledge Gap in Topics Which are Placed in Elementary Curricula (30)
*Providing Classroom Arrangement (28)		*Concept Teaching (27)	*The Probability of Not Answering Students' Questions in Classroom (18)
*Developments in *Science and Technology (24)		*Time Organizing (23)	*Theoretical Knowledge (30)
*Creative Drama (32)		*Application	*Being Far Away From Science Topics (22)
*Activity-Based Teaching (30)		Laboratuary (22)	*Having Problem What Amount to Give or Not to Give (22)
*Application of Unit Plans in Real Environments (32)		*Curriculum (26)	*Theoretical Knowledge Given to the Students (31)

Tablo 1 Continued

Experimental Group		Control Group	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
*Topics of the Area (17)		*Developments in Science and Technology (22)	*Gaining High Level of Outcomes (28)
*Heat (12)			*Application of Creative Drama (32)
*Temperature (12)			*Measurement and Evaluation (35)
*Velocity (9)			*Science Fair (16)
*Speed (9)			*Not Learning the Topics that They Should Teach (21)
*Translation Motion (6)			*Topic of Heat and Temperature (15)
*Genetics (10)			*Topic of Pressure (14)
*Physics Topics (17)			*Application (32)
*Constructivism (22)			*Fear Can Not to Give Answers to Students' Interesting Questions (8)
*Multiple Intelligence (13)			*Estimating in a Wrong Way (5)
*Theory (17)			
*Electricity (10)			
*Pressure (10)			
*Alternative Measurement and Evaluation Methodologies (29)			
*Individual Working Method (22)			

Table 2
The Points Which Are Felt Well and Qualified in Science Education

Experimental Group		**Control Group**	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
* Theoretical use of methods and techniques (32)	*Using alternative learning and teaching methods that can be used in Science and Technology (35)	* Having the theoretical knowledge of using methods and techniques in science education (35)	*Human and Environment Unit
	*Designing Activities Suitable to Curriculum Vision and Constructivist Approach (30)		*Learning by Living and Doing (18)
	*Preparing Original Activities According to the Outcomes During The Investigation Process of a Topic From a Unit (22)		*Having Good Communications With Students (19)
	*Using Science process skills Everywhere (30)		*Having a Control of Content (16)
	*Using Measurement and Evaluation Approaches Which Are Suitable to Process (29)		*Using Laboratuary (14)
	*Preparing Original Graded Scoring Keys (Rubrics) and Performance Assessment Forms Which Are Proper to Topics (32)		*Conducting Experiments (14)
	*Preparing Puzzles, Funny Science Cartoons, Concept Cartoons,Stories, Problem Scenarios,Enigmas,Poems,Creative Thinking Practices (24)		*Having Different Views (19)
	*Preparing Activities Which Are In Curriculum (30)		*Making Relations (20)
	*Believing to Do All Necessities of Science and Technology Course (32)		*Gaining Higher Order Thinking Skills (19)
	*Being Superior Of the Other Universities (17)		*Making Students Active (16)
	*Using Lesson Plans in an Effective Way (29)		*Using alternative Methods and Techniques (21)
	*Communication Skills (21)		

Table 3
Mostly Selected Methods and Techniques in Science Education

Experimental Group		Control Group	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
* Discussion (22)	*Problem-Based Learning (34)	* Traditional and Alternative Learning and Teaching Approaches (22)	*Methods Which the Students can be Active (20)
* Creative Drama (14)	*Project-Based Learning (34)	*Presentation (22)	*Considering Individual Differences of Students (19)
* Educational Plays (16)	*Using Inquiry and Research Method Proper to Constructivist Approach (30)	*Question-Answer (31)	*Conducting Experiments (31)
* More than one method or technique (12)	*Creative Drama (32)	*Discussion (26)	*Presentation (32)
*Inquiry-Based Learning (15)	*Six Hats Thinking Technique (34)	*Six Hats Thinking Technique (12)	*Providing Students to Have Meaningful Learnings (31)
*Following the Steps of Scientific Process (11)	*Brain Storming (30)	*Creative Drama (12)	*Project-Based Learning (24)
*Preparing Projects (19)	*Providing Students Learning By Living, Doing, Applying and Producing Solutions (26)	*Multiple Intelligences Theory (10)	*Question-Answer Method (34)
*Making Observations and Experiments (21)	*Feeling events (18)	*Group Workings Which The Students Can Interact Each Other (18)	*Activities (28)
*Learning by Living and Doing (20)	*Learning by Living Technology (21)	*Performance Homework (16)	*Group Works (21)
*Make Students Active (21)	*Taking a Trip (29)	*Collaborative Learning (15)	*Brain-Storming (14)
*Activity (20)	*Observation (30)	*Group Working (18)	*Showing-Done (11)
*Project-Based Learning (18)	*Animate by Living and Doing (22)	*Project-Based Learning (20)	*Inquiry-Based Learning (19)
*Presentation (24)	*Student-Centered Methods and Techniques (33)	*Identifying Prior Learnings (16)	*Learning by Searching (29)
*Showing Done (18)	*Providing Learning By Living and Doing (29)	*Presenting With Applications (25)	* Drama (14)

Table 3 Continued

Experimental Group		Control Group	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
*Question-Answer (32)	*Make Students Actively Participated From the Passive Recipients (31)	*Experiments (22)	
*Six Hats Thinking Technique (12)	*Question-Answer Which Provides Active Participation (26)	*Concept Maps (19)	
*Group Working (21)	*Discussion Methods (24)	*Brain-Storming (12)	
*Problem-Based Learning (20)	*Individual Learning Method (21)	*Performance Show (14)	
*Collaborative Learning Methods (14)	*Selecting Methods and Techniques By Looking at the Outcomes (23)	*Interview (15)	
*Journey (9)	*Performance-Based Activities (31)	*Observation (18)	
*Observation (14)	*Problem Solving (31)	*Outdoor Activities (20)	
*Interview (17)	*Sample Event (11)		
*Outdoor Activities (19)	*Showing Done (11)		
*Constructivist Approach (21)			
*Student-Centered Activities (22)			
*Concept Maps (19)			
*Identifying Method or Technique Relating to the Topic (11)			
*Multiple Intelligence (9)			

Table 4

The Reasons of the Selecting Methods and Techniques in Science Education

Experimental Group		**Control Group**	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
*Directing Students to Think, Inquire and Problem Solving (18)	*Developing Students' Problem Solving and Understanding Skills (26)	*Developing Students' Science process skills (20)	* Not a Good or a Bad Method (12)
*Developing Positive Attitudes Towards the Course (15)	*Providing Students To Understand the Scientific Method and the Nature of Science (22)	*Providing Learnings Are Permanent (18)	*Methods Are Selected Through the Topics (15)
*Developing Students' Science process skills and Higher Order Thinking Skills (20)	*Developing Positive Attitudes Towards the Course (32)	*Relating to Daily Life Situations (22)	*Every Method Can Not Be Effective (14)
*Motivating Students' Active Participation (15)	*Being Respectful to Others' Views (29)	* The Cognitive Level of Students (14)	*Changing of Methods and Techniques According to Class Level (19)
	*Providing Students to Learn By Living, Doing, Applying and Producing Solutions (25)	* The Difference of the Content (16)	*Physical Condition of School (18)
	*Students' Learnings With Their Individual Speed (22)		*Conditions of Students (17)
	*Science Education Has a Relationship With Daily Life (32)		*Developing Students' Science process skills (18)
	*Motivating Students' Active Participation (30)		*Providing Students Actively Participated (19)
	*Containing Higher Order Cognitive Activities (24)		*Identifying Prior Learnings of Students (20)
	*Aiming Reconstruction and Holistic Change (28)		*Providing Learnings Are Permanent (22)
	*Developing Students' Science process skills and Higher Order Thinking Skills (34)		*Relating to Daily Life Situations (19)
	*Directing Students to Think, Inquire and Problem Solving (29)		*Directing to Research (16)
	*Providing Students' Active Participation (35)		*Solving Daily Life Problems (20)
			*Providing to Strengten the Knowledge (22)

Table 5

The Characteristics of Successful Science Teacher

Experimental Group		Control Group	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
*Having Content Knowledge (32)	* Giving Importance to Personal and Professional Development (34)	*Qualified in Content Knowledge (33)	*Doing the Work by Loving (21)
*Curious (21)	*Being Respectful to Individual Differences (28)	*Have Effective Communication Skills (22)	*Being Creative (17)
*Open to Developments (25)	*Open to Changes and Improvements (35)	*Be Able To Use New Approaches and Methods (24)	*Well-Developed Communication Skills (23)
*Researcher (20)	*Understanding the Nature of Science and Technology (32)	*Be Able To Develop Her or Himself (21)	*Know How and What to Say (18)
*Sharer (19)	*Giving Importance to Scientific Process and Its Steps (32)	*Qualified For the Application of Technological Materials (18)	*Qualified in Classroom Management (22)
*Considerate (23)	*Having the Knowledge of Curriculum and Its Content (29)	*Expert in Classroom Management (26)	*Making Activities Regularly (18)
*Patient (18)	*Using Alternative Learning and Teaching Techniques (32)	*Directing Time Well (22)	*Planning Time Well (24)
*Self Consistent (22)	*Providing Individual and Colloborative Learning Environments According to Students' Developmental Levels and Learning Styles (22)	*Equipped for Activity and Experiment (25)	*Preparing Unit Plan (19)
*Programmed (17)	*Using Complementary Measurement and Evaluation Approaches (30)	*Fair (14)	*Using Different Methods and Techniques (18)
*Fair (15)	*Considering Students' Interests and Needs (29)	*Democratic (5)	*Considering Students' Interests and Needs (21)
*Providing students to be scientific literarers (17)	*Reaching Different Resources (22)	*Investigate Through the Different Views (16)	*Giving Importance to Prior Knowledge and Individual Differences (16)
*Having Good Relations With Students (18)	*Open to Develop Firstly In Science Topics and In Other Topics (20)	*Considering the Individual Differences (21)	*Having Good Shape (7)
*Love to teach and learn (26)	*Providing Communication Between Student-School-Parent and School Management (21)	*Developed Higher Order Thinking Skills (20)	*Being Smooth-Faced (8)

Table 5 Continued

Experimental Group		Control Group	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
*Successful in Educational Sciences (12)	*Creating Democratic Environment in Classroom (18)	*Bound With Ataturk's Principles and Revolutions and Transfer Them to Her or His Students (11)	*Having Content Knowledge (22)
*Reflecting his or her learning desire and emotion to the students (14)	*Democratic (9)	*Have Researcher Identity (18)	*Being a Good Guide (19)
*Give Value to the Students (21)	*Full-Equipped About Theoretical Knowledge (24)	*Be Aware of Technological Developments and Changes in the Fields (24)	*Updating Her or Himself About Educational and Scientific Areas (21)
*Growing Creative People (15)	*Giving Value to Students (24)	*Giving Speech to the Students Regularly (14)	*Communicating With Parents (18)
*Eliminating Misconceptions (9)	*Including Students in Learning and Teaching Process (32)	*Using Materials, Video, Poster in the Course (21)	*Democratic (6)
*Continuing Her or His Development (21)	*Doing Laboratuary Studies Easily (24)	*Be Aware of the Needs of the Students (16)	*Giving Value to Students (20)
*Developing His or Her General Culture (19)	*Being Able To Use Traditional and Alternative Measurement and Evaluation Approaches (32)	*Constructing Activities Which Develop Students' Higher Order Thinking Skills (18)	*Adding Students to the Teaching and Learning Environment (17)
*Never Disgusting (16)	*Executing Student-Centered Studies Successfully (28)	*Directing Interpretation, Not Memorization (14)	*Making Laboratory Activities Easily (25)
*Be Able To Make Interpretations (21)	*Energetic (19)	* Being Tolerant (18)	*Energetic (15)
*Transferring Learnings to the Daily Life Situations Without Materials (26)	*Humorous (21)	*Skill of Classroom Control (23)	*Humorous (15)
*Know Topic Well (25)	*Giving Place to Outdoor Activities in Learning and Teaching Environment (30)	*Skill of Laboratuary Using (18)	*Giving Importance to the Outdoor Activities (12)
*Know Effective Presentation Techniques (22)	*Working Always Hard to Develop Her or Himself (22)		*Using Modern Methods and Techniques (19)
*Organizing Classroom Effectively (25)	*Being Guide Than Being Authoritarian (32)		*Contemporaneous (16)

Table 5 Continued

Experimental Group		Control Group	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
*Love His or Her Profession (18)	* Being Loved and Respected Her or Himself Without Making Pressure (24)		*Rational
*Reconciled With His or HerSelf and Environment (12)	*Doing Teaching Profession By Protecting Its Blessedness (19)		Learning With Students (22)
*Be Loved With Students (18)	*Comes Close to Students With Thinking of They are The Future of the Country (12)		*Scientific Literarers
*Love Students and Profession (21)	*Following the Studies in the Field (12)		*Having Pscyhology Knowledge (9)
*Aware of Technological Developments (19)	*Being a Good Model to the Students (26)		*Being Respectful to Atatürk's Principles and Revolutions (8)
*Having Problem Solving Skills (16)	*Directing Students to Think, Inquire and Solve Problems (24)		*Having Self-Confidence (11)
*Having Communication Skills (18)	*Making Students Scientific Literarers (32)		*Loving Teaching as a Profession (13)
*Following Technological Developments (19)	*Qualified in Her or His Field (17)		
*Following Students By Their Individual Differences (15)	*Continuously Researcher (16)		
*Skill of Classroom Control (19)	*Continuously Learning (16)		
*Skill of Laboratuary Using (18)	*Having Good Relations With The Students and Their Families (23)		
*Giving Importance to Science process skills and Scientific Literacy (21)			
*Know How to Tranfer Knowledge to Students (25)			

Table 5 Continued

Experimental Group		Control Group	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
*Being Tolerant (17)			
*Having High Energy (12)			
*Explaining the Relationship Of the Science and Technology and the Daily Life (17)			
*Not Going to Easy (14)			
*Continuously Reading (11)			
*Growing Students Who Know Every Science Learning Has an Explanation in Nature (18)			
*Continuously Develop Her or Himself (19)			
*Having Empathy Skills (12)			
*Having Creative Thinking Skill (16)			
*Making Organizations (14)			
*Making Relationships Between Student-Teacher-School Management and Parent (8)			
*Integration of the Differences to the Course (11)			
*True Followers of Student Learnings (4)			

Table 6

The Place of Science Teaching Methods Course in Science Education (Good Points in Science Teaching Methods II Course)

Experimental Group		**Control Group**	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
*Learning New Approaches,Methods and Techniques (19)	* It is A Very Necessary Course In Science Education (36)	* Teaching New Different Approaches and Methods (19)	*Having a Special Importance (13)
*Teaching of Methods and Techniques Which Will Be Used in Teaching Profession (35)	*Relating to the Field (22)	*Teaching How to Teach Science (22)	*Participating the Profession Well-Equipped and Capable (9)
*Detailed Knowledge About Science Education (32)	*Learning Methods and Techniques (32	*Transferring Theoretical Knowledge to The Applications (30)	*Learning Approaches, Methods and Techniques That Will Be Applied (21)
*Helping Students To Be a Teacher (30)	*Applying Methods and Techniques to the Units in Curriculum (38)	*Showing the Application Processes of All Methods and Techniques (23)	*Giving More Place to Applications (17)
*Very Effective (23)	*Having Very Important Experiences About the Applications (32)	*Application of Different Methods and Techniques (24)	*Transferring Learnings of Preservice Science and Technology Teachers to the Application (15)
*Problem-Based Learning (25)	*Gaining Vision Before Starting Teaching Profession (26)	* Having The Qualification of Lesson Planning (22)	*See New Methods and Approaches (18)
*Project-Based Learning (25)	*Bringing Different Dimension to the Content, Classroom Environment and Students (31)	* Detailed Knowledge About Science Education (27)	*See Good Samples (12)
*Knowledge and Application Process of Curriculum (29)	*Expandition in Content Knowledge (25)	* Declaim to Individual Differences (21)	*Most Important Part of Science Education (29)
*Know How to Organize a Unit (32)	*Eliminating Misconceptions (28)	* Know How to Organize a Unit (29)	*Not Know How to Conduct Units (12)
*Considering Individual Differences (21)	*Preparing Unit Plans (35)	*Effective (19)	*Course With the Integration of Other Courses (9)
*The Most Important Education Course (22)	*Preparing Activity Reports (29)	* Showing Students To Be A Teacher (25)	*Planning Activities According to Student Levels (12)
*Directly Application (19)	*Providing Creative Thinking (33)	*Very Important (29)	*Understanding and Applying Problem-Based Learning and Project-Based Learning (17)
*Learning for Complementary Measurement and Evaluation Approaches (18)	*Developing Positive Attitudes to Teaching Profession (32)	* Knowledge and Application Process of Curriculum (32)	*Providing Learning With Homework (32)

Table 6 Continued

Experimental Group		Control Group	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
*Having The Qualification of Lesson Planning (32)	*Gaining Science process skills (35)		*Important for Teaching and Applying Alternative Techniques (19)
*See How to Teach and Learn Effectively and Easily (27)	*Increasing Dominion in Curriculum Content (27)		*All Preservice Teachers Should Take (22)
*Important (25)	*Basic of Teaching Course (21)		*Important for Introducing the Applications in the Field (12)
*Having View About What Kind of Educational System Is Desired (19)	*Learning How to Teach Science (34)		*Having Control About Teacher Qualifications (11)
*Developing New Methodologies According to Themselves (16)	*Good Preparation During Pre-Service Education (36)		*Being Well-Equipped (18)
*It should be taken by all pre-service teachers (32)	*Learning and Applying Knowledge Which Construct Basic to the Applications in Teaching Profession (29)		*Learning to Prepare Concept Map, Diagnostic Branching Trees…etc. (6)
*Declaim to Individual Differences (19)	*Starting to Apply Knowledge Which Preservice Teacher Has Learned This Time (31)		*Learning How to Use Methods and Techniques (19)
	*Learning New Approaches and Methods (35)		*Having First Footstep to Teaching Profession in This Course (5)
	*See Good Samples (32)		*Course is Theoretically Processed (32)
	*Having Experience How the Different Methods and Techniques Are Used Together (25)		
	*Thinking About How the Daily Plans Are Written and Applied (33)		
	*Using Creativity (29)		
	*Spending Effort for the Students to Love Science (25)		
	*It is one of the rarely educational applicative course in department (12)		
	*Having the Qualifications of a Teacher (24)		
	*Having Control in Measurement and Evaluation Approaches (27)		
	*Course is effective and permanent because active participation of students (28)		
	* Undoubtedly taken from the preservice teachers for their professional and personal development (27)		

Table 7
The Parts which should be improved in Science Teaching Methods II Course

Experimental Group		Control Group	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
*Feedback (35)	*Preparation of Lesson Plans for Every Unit and Every Week (12)	*The Application of Homework in Classroom Environments (21)	*Micro-Teaching Applications (5)
*Examples of Student Studies (29)	*Plans have an Effect in Measurement and Evaluation Process (12)	*Applicability of Homework in Daily Life (28)	*Avoiding From Repetitions (28)
*More Examples from Methods and Techniques (32)	*Preparing Questions in Every Week (12)	*Feed Back (32)	*Giving Place to Group Works More (32)
*Explaining Failure and Gaps of Applications (33)	*Applying Daily Plans By Animation (15)	*Application of the Activities in Practice Schools (24)	*Giving Theoretical Knowledge More Effectively (30)
*Making Relations With Other Courses (19)	*Recording Applications In Schools and Then Interpretation of These (32)	*Testing If The Activity Is Productive or Not. (25)	*Making Discussions and Giving Feedback to Homework (32)
*Identifying The Needs (22)	*Sharing Samples of Applications in Class (30)	*The Applications of Problem-Based Learning and Project-Based Learning (30)	*Telling How to Design Courses in Different Situations (25)
*Preparation of Homework (29)	*Applying the Products of Science Teaching Methods II Course in Teaching Applications in Schools. (32)	*Making Studies During Course Process (21)	*Showing the Applicability of the Work Done in Course (29)
*Teaching How to Prepare Unit (32)		*Giving Importance to Application During Science Education (32)	*Activities Should be Done For Applications (32)
*Application (35)		*Group Works (32)	*Processing Course With Video or Simulations (21)
*Making Practices (35)		*Activities Which Everybody Can Participate (32)	*Learning Activities Which Consist of Five Sense (18)
*Speedy and Effective Process Assessment (18)		*Telling the Missing Sides of Homework (35)	*Telling to Real Students Instead of Class Mates (15)
*Group Workings (29)		*Assessing Prior Learnings (32)	*Student-Centered Activities Should be Done (32)

Table 7 Continued

Experimental Group		**Control Group**	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
*Course With Applications (27)		*Make Assessment With Students (32)	*Contradiction About Power-Point Slayt and Teacher Sayings (21)
*Aware of Actual and New Techniques (25)		*Criteria of Homework Should be Given (32)	*Increasing the Application Dimension (30)
*Processing Parallel With School Applications (17)			*Approaches like Project-Based Learning Should be Used More (25)
*Having Feedback From The Application of the Lesson Plans in Schools (32)			*Topics Should be Processed in a Detailed Manner (19)
*Assessing Prior Learnings (21)			*Methods and Techniques Should be
*Adapting Lesson Plans to Every Unit (24)			Given in a Detailed Manner (22)
*Discussion of the Presentations (28)			* Directing to More Specific Area (15)
*Criteria of Homework Should be Given (32)			*Being Meaningful
*Studying With Activities (29)			*Having More Work With New Methods and Techniques (28)
*Processing With Making Relation to Other Methods and Techniques (19)			*Doing Applications (31)
*Applying in Real Environments (22)			*Transferring of Techniques to the Course Should be Given (28)
*Taking Interpretations of Students About Plans (31)			*Having Firststep to Teaching Profession in This Course (23)
*Make Assessment With Students (29)			*Processing Class According to Elementary Level (19)
*Taking The Application of Methods in Video Camera and Watching (21)			*Using Techniques Like Brain-Storming and Six Hats Thinking Technique (29)

Table 8
Expectations before Science Teaching Methods II Course

Experimental Group		Control Group	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
* Effective Application of Methods and Techniques (33)		*Understanding the Constructivist Approach (32)	
*Understanding and Applying the Curriculum (34)		*Predominance of the Curriculum (28)	
*Domination of Curriculum (25)		*Learning Alternative Learning and Teaching by Application (30)	
*Methods and Techniques (33)		*Questions Which Develop Higher Order Thinking Skills (28)	
*Measurement and Evaluation (33)		*Gaining Experience About the Preperation of Unit Plan, Daily Plan and Activities (30)	
*Understanding How The Teacher is Guide (30)		*Using Measurement and Evaluation Methods and Techniques (30)	
*Understanding How the Students are Active (30)		*Application of Science process skills (32)	
*Multiple Teaching Methods and Techniques (32)		*Eliminating the Gaps in Science Teaching Methods I Course (27)	
*Transferring Knowledge to the Practices (32)		*Constructing Activities (25)	
*Making Research		* Developing Activities For Every Topic (25)	
*Adapting Methods and Techniques Into the Constructivist Approach (30)		*Know How the Teacher Behaves (22)	
*Applying Different Methods and Techniques in Suitable Places (30)		*Preparing and Applying Lesson Plans According to Constructivist Approach (30)	

Table 8 Continued

Experimental Group		Control Group	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
*Application of Activities (32)		*Multiple Teaching Methods and Techniques (28)	
*Preparing Lesson Plans By Using Different Process-Based Measurement and Evaluation Approaches and Methods (28)			
*Internalizing Methods and Techniques (26)			
*Investigating Units in a Detailed Manner (28)			

Table 9

Knowledge and Skills Which Were Gained after Science Teaching Methods II Course

Experimental Group		Control Group	
Before Implementation	**After Implementation**	**Before Implementation**	**After Implementation**
	*The Knowledge of Content and Curriculum (35)		* Having Control in Curriculum (27)
	*Preparation of Course Plans and Activities (35)		*Methods and Techniques (25)
	*Recognizing and Differentiating		*Measurement and Evaluation Methods and Techniques (20)
	Approaches, Methods and Techniques (25)		*Preparing Course Plan (32)
	*Application of Approaches, Methods and Techniques in Science Education (35)		*Theoretical Part
	*Learning Different Teaching and Learning Methodologies (32)		Was Not Productive (32)
	*Applying Creative Drama (29)		*Not Developed So Much (32)
	*Identifying Problem Statement (19)		*Can be Found by Web (21)
	*Having Control of Teaching Methods and Techniques (30)		*Learning by Living and Doing (17)
	*Transferring to Application of Knowledge That Has Learned For All Undergraduate Education (21)		*Applications in Science Education (21)
	*Learning by Living and Doing (33)		*Understanding Project-Based Learning Model Theoretically (30)
	*Using Complementary Measurement and Evaluation Approaches (35)		*Having Experience About Preperation of Daily Plans (28)
	*Understanding Exactly What Really The Constructivist Approach Is (35)		*Learning Different Methods and Techniques (31)
	*Learning How to Apply Methodologies (32)		*Learning the Importance of Developing Scientific Method and Thinking (16)
	*Being More Successful in Science Education (28)		*Developing About Skills (15)
	*Being Well Developed Owing to the Performance Work and Presentations (22)		*Recognizing the Science Education Content in a Detailed Manner (18)
	*Learning How to Design Course (33)		*Know the Logic of the Process (15)
	*Identifying Which Techniques and Measurement and Evaluation (28)		*Organizing Activity (30)
	Approaches Can be Used During the Process (22)		*Recognizing New Methods and Techniques (21)

APPENDIX P

Sample Lesson Plan

Week 2: General Characteristics of Science and Technology Curriculum

Rationale

This is the second unit for Science Teaching Methods II course. There are several characteristics which cover this unit were given as follows;

(1) Identfying the students' prior knowledge about newly developed Science and Technology Curriculum

(2) Recognizing students' misconceptions about general philosophy of Science and Technology Curriculum

(3) Exploring and discussing the basic concepts and principles of science education

(4) Understanding the development, implementation and assessment processes of Science and Technology Curriculum

(5) Providing a constructivist learning environment in which learners recognize the principles of preparing a constructivist learning environment to their students.

Goals and Objectives of the Unit

Lower-level Cognitive Outcomes

After processing this unit, students;

1. Explain the general characteristics of Science and Technology Curriculum

1.1. Explain the term of "Scientific Literacy" and its dimensions.

1.2. Explain the term of "Constructivist Approach" and its implications to the teaching and learning environment.

1.3. Understand the Science-Technology-Society-Environment relationships and their connections with the Science and Technology Curriculum

1.4. Tell the attitude and value outcomes of Science and Technology Curriculum

1.5. Explain the kinds of methodologies used in the implementation and assessment process of Science and Technology course.

2.Understand the duties of curriculum development team

2.1. Explain the field experts' duties in Science and Technology Curriculum Development Team

2.2. Explain the program developers' duties in Science and Technology Curriculum Development Team

2.3. Explain the measurement and evaluation experts' duties in Science and Technology Curriculum Development Team

Higher level cognitive outcomes

3. Make interpretations and inferentions about the general philosophy of Science and Technology Curriculum

3.1. Identify and write their own ideas about the development process of Science and Technology Curriculum

3.2. Recognize the probable problems about curriculum development process and Science and Technology Education.

3.3. Identify the similarities and differences between the concepts related to the Science and Technology Curriculum

Affective Outcomes

4. Give value to the preparation process of Science and Technology Curriculum

4.1. Recognize the importance of Constructivist Learning Approach.

4.2. Internalize the general idea and fundamental concepts of Science and Technology Curriculum.

4.3. Value group working and other friends' different ideas.

4.4. Carry responsibility for others' learning in the working environment.

Performance Outcomes

5. Prepare and present a report about the preparation and implementation process of Science and Technology Curriculum

5.1. Integrate different people's ideas and reflect into a report
5.1. Identify criteria about their performances.
5.2. Write a report according to criteria
5.3. Prepare a presentation about the report and present.
5.4. Realise their own cognitive and affective development about Science and Technology Curriculum.

Time: 4x50 minutes
Number of students: 53
Approaches, Strategies and Techniques: Problem-based learning approach, question-answer technique, writing in a role technique, creative drama method, discussion method, group working technique.
Expected Student Skills: Creative thinking, critical thinking, analyzing, synthezing, realizing how to learn (meta-cognitive thinking), group interaction.
Content: General Principles and Fundamental Concepts of Science and Technology Curriculum
Level: Senior Faculty of Education Department of Science Education students.
Materials: Different pieces of paper, pencils, colorful markers, whiteboard and boardmarker.

First Level: Starting the lesson (Invitation)

Teacher asks students about what they know about the general philosophy of Science and Technology Curriculum. Teacher lists what the students tell. After that teacher wants students to prepare questions about the concepts that are written on the board. Teacher wants from the students for looking at the board and identify if there is a problem in their mind. Also teacher asks questions about the concepts like "What do you think here? Why do you think in this way? Are you sure?"

Second Level: Continuing the Lesson (Research-Exploration)

Students count from 1 to 10 and each number comes together and groups which consist of 4 or 5 students are constructed. Time is given for students to discuss about the topics which the teacher writes on the board. Teacher wants students to do brainstorming for this. After this activity teacher told the students that "You are the experts of Physics, Chemistry, Biology disciplines, program developers and measurement and evaluation experts who are the members of the Commission of Curriculum Development. Please share your roles in this team. When you think about the general principles, fundamental philosophy and concepts of Science and Technology Curriculum, what can you do about the carrying out the curriculum? What are your aims, goals and objectives? What kind of teaching and learning environment will you organize and what are your reasons about this? Also what kind of teaching and learning approaches, strategies and techniques do you want to use? What kind of measurement and evaluation approaches, strategies and techniques do you want to use and what are your detailed justifications about them?" and teacher want groups to do this in a discussion environment. Teacher also want groups to prepare a report for reflecting their findings and interpretations. Preparing criteria for their report is wanted by the teacher from the groups. After this, students will present their reports.

Third Level: Proposing Explanations and Solutions

Teacher listens group presentations in this level. After the presentations end, groups say their own ideas about the different groups' ideas. Teacher shares the topic of "Fundamental Characteristics of Science and Technology Curriculum" and explains the philosophy and general concepts related to newly develpoed Science and Technology Curriculum. Teacher discusses the examples and group ideas and discuss the similarities and differences in the classroom environment.

Fourth Level: Conclusion-Taking Action

After teacher explains the general concepts, fundamental characteristics and phiolosophy of Science and Technology Curriculum, ask students how they can integrate their learning to the daily life situations? Teacher identifies students' interpretations and provide social interaction for students to show them in a model or example.

APPENDIX R

Constructivist Learning Model Criteria for Lesson Plans

Dear Expert;

Please investigate the lesson plans with dimensions of Yager (1991) proposed a "Constructivist Learning Model" for use in science teaching and offered following strategies for implementing a constructivist lesson. Please deeply investigate lesson plans;

1. If the criteria which were given below integrated to lesson plans
2. If the lesson plans will be applicable and suitable to constructivist learning approach and
3. If the lesson plans will make an effect on participants' learning, skills and attitudes

Starting the lesson:

1) Observe surroundings for points of curiosity.
2) Ask questions.
3) Consider possible responses to questions.
4) Note unexpected phenomena
5) Identify situations where student perceptions vary.

Continuing the lesson;

1) Engage in focused play.
2) Brainstorm possible alternatives.
3) Look for information.
4) Experiment with materials.
5) Observe a specific phenomenon.
6) Design a model.
7) Collect and organize data.
8) Employ problem-solving strategies.
9) Select appropriate resources.
10) Students discuss solutions with others.
11) Students design and conduct experiments.

12) Students evaluate and debate choices.

13) Define parameters of an investigation.

Proposing explanation and solutions:

1) Communicate information and ideas.

2) Construct and explain a model.

3) Construct a new explanation.

4) Review and critique solutions.

5) Assemble appropriate closure.

6) Integrate a solution with existing knowledge and experiences.

Taking action:

1) Make decisions

2) Apply knowledge and skills.

3) Transfer knowledge and skills.

4) Share information and ideas.

5) Ask new questions.

6) Develop products and promote ideas.

7) Use models and ideas to illicit discussions and acceptance by others.

APPENDIX S

Probable Themes

1) Fen Öğretimiyle İlgili Yeterli Hususlar (Good and Qualified Points in Science Education)

2) Fen Öğretimiyle İlgili Geliştirilmesi Gereken Hususlar (The Parts Which Should be Developed in Science Education)

3) Fen Öğretimindeki Eksikliklerin Nedenleri (The Reason of the Deficiencies in Science Education)

4) Fen Öğretiminde Kullanılması En Çok Tercih Edilen Yaklaşım, Yöntem ve Teknikleri (The Approaches, Methods and Techniques Which Mostly Preferred in Science Education)

5) Yaklaşım, Yöntem ve Teknikleri Kullanma Nedenleri
(The Reason of the Selection of the Approaches, Methods and Techniques)

6) Örnek Alınacak Alanında Başarılı Fen Bilgisi Öğretmeni Özellikleri
(The Characteristics of a Successful Science Teacher)

7) Alandaki Fen Bilgisi Öğretmenlerinin Eksik Yönleri ve Nedenleri
(The Areas of Strenghts and Weaknesses of Science Teachers and their Reasons)

8) Eksikliklerin Tamamlanabilmesi İçin Öğretmen Eğitiminde Yapılması Gerekenler
(The Parts Which Should be Done For Areas of Strenghts and Weaknesses)

9) Özel Öğretim Yöntemleri II dersinin Fen Bilgisi Öğretimindeki Yeri ve Önemi
(The Importance of Science Teaching Methods II Course in Science Education)

10) Özel Öğretim Yöntemleri II dersinin İşleniş Süreciyle İlgili Olumlu Yönler
(The Positive Parts in Science Teaching Methods II Course)

11) Özel Öğretim Yöntemleri II dersinin İşleniş Süreciyle İlgili Geliştirilmesi Gereken Yönler
(The Parts Which Should be Improved in Science Methods II course)

12) İlk Sekiz Haftalık İşlenişle İlgili Olumlu Yönler
(The Positive Parts in First Eight Weeks)

13) İlk Yedi Haftalık İşlenişle İlgili Geliştirilmesi Gereken Yönler
(The Parts Which Should be Developed in First Eight Weeks)

14) Grup Çalışmalarıyla İlgili Düşünceler
(Views about the Group Works)

15) Süreçte Yapılanların Oluşturmacı Yaklaşımla İlişkisi
(The Relationship Between The Activities Which Were Done in Process with Constructivist Approach

16) Özel Öğretim Yöntemleri II Dersi Sonunda Kazanılan Beceriler
The Skills Which Were Gained at the End of Science Teaching Methods II Course

17) Eklenmek İstenilenler
Additional Points

APPENDIX T

Summary in Turkish

ÖZEL ÖĞRETİM YÖNTEMLERİ II DERSİNDE OLUŞTURMACI ÖĞRETİMİN BAŞARI, TUTUM, BİLİMSEL SÜREÇ BECERİLERİ VE KALICILIĞA ETKİSİ

Bu çalışmanın amacı dördüncü sınıf fen bilgisi öğretmen adaylarının Özel Öğretim Yöntemleri II dersi kapsamında ders başarısı, fen öğretimine karşı tutum, bilimsel süreç becerileri ve kalıcılıklarına etkisini incelemektir.

Çalışmaya Ankara ilindeki devlet üniversitelerinde birinde Eğitim Fakültesi Fen Bilgisi Eğitimi Anabilim Dalı'nda öğrenim görmekte olan dördüncü sınıf öğrencileri katılmıştır. Süreçte bir deney bir kontrol grubu olmak üzere iki grup yer almaktadır. Araştırma sürecinde deney grubunda oluşturmacı öğretimle ders işlenirken kontrol grubunda geleneksel yöntemle dersler devam etmiştir.

Araştırmanın deseni yarı deneysel desendir. Bu nedenle örneklem seçiminde ulaşılabilir örnekleme yoluna başvurulmuştur. Araştırmanın örneklemini deney grubunda 53, kontrol grubunda 50 olmak üzere toplam 103 dördüncü sınıf fen bilgisi öğretmen adayı oluşturmaktadır. Grupların denkliğini kontrol etmek için Bilimsel Süreç Becerileri Testi, Fen Öğretimine Karşı Tutum Ölçeği ve Başarı Testinden elde edilen ön test puanları t-test ile karşılaştırılmış ve gruplar arasında anlamlı bir farklılık bulunmamıştır.

Araştırma, 2007-2008 Akademik yılı Güz Döneminde toplam 15 hafta devam etmiştir. Uygulama öncesi, sonrası ve 10 hafta sonrasında gruplara Bilimsel Süreç Becerileri Testi, Fen Öğretimine Karşı Tutum Ölçeği ve Ders Başarı Testi uygulanmıştır. Üç testin üç kez uygulamasından elde edilen veriler 3X2 tekrarlı ölçümler için varyans analizi (ANOVA) kullanılarak değerlendirilmiştir.

Ayrıca araştırma öncesinde ve sonrasında fen bilgisi öğretmen adaylarının ders süreci ile ilgili algılarını, fen öğretimine yönelik düşüncelerini belirlemek üzere deney ve kontrol grubundaki öğrencilere anket uygulanmış, araştırma süreci ve sonrasında ders sürecindeki başarıları ve ankete verdikleri cevaplar göz önünde bulundurularak yarı yapılandırılmış odak grup görüşmeleri için deney grubundan 6 kontrol grubundan 6 olmak üzere toplam 12 öğretmen adayıyla yarı yapılandırılmış odak grup görüşmeleri gerçekleştirilmiştir.

Araştırma sonunda ön test puanları ile son test puanları arasında deney grubu lehine anlamlı bir fark bulunmuştur. Kalıcılık puanları açısından her iki grupta da fen öğretimine karşı tutum ve ders başarıları açısından istatistiki olarak anlamlı olarak ifade edilebilecek bir düşüme yaşanmış, deney grubunun bilimsel süreç becerileri ortalamasında istatistiki olarak anlamlı bir düşme gözlenirken kontrol grubundaki bilimsel süreç becerileri ortalamasında istatistiki olarak anlamlı bir değişiklik saptanmamıştır. Gerek vardamsal istatistik uygulanan üç testten elde edilen bulgular gerekse anket ve görüşme sorularının nitel analizinden elde edilen bulgular oluşturmacı temelli öğretimin fen öğretmen adayları için öğrenme ve öğretme ortamlarında etkili bir öğrenme öğretme yaklaşımı olduğunu göstermektedir.

1. Giriş

Oluşturmacı Öğrenme Yaklaşımı Türkiye'de ilk olarak uluslar arası sınavlardaki başarı durumumuzun değerlendirilmesi ve ilköğretim programlarındaki yeniden yapılanma sürecinin ardından önem kazanmaya başlamıştır. Oluşturmacı Öğrenme Yaklaşımıyla ilgili geçmişte pek çok araştırma yapılmış, eğitim alanında yapılan araştırmalar ise 1990 yılında önem kazanmaya başlamıştır.

Oluşturmacı yaklaşımın temelleri antik çağlara Sokrat diyaloglarına dayanır. Sokrat diyalogları, öğrenenlerin kendilerini değerlendirip düşünme süreçlerini analiz etmelerine yardımcı olan bir yöntemdir. Sokrat diyalogları halen oluşturmacı eğitimciler için öğrencilerinin öğrenmelerini değerlendirmede ve öğrenme ve öğretme ortamlarını düzenlemede önemli birer ipucu olarak kullanılmaktadır.

Oluşturmacılığın birçok bilim insanı tarafından tanımı yapılmıştır. Oluşturmacılık, bilgi ve öğrenmeye ilişkin bir teoridir, bilme ve öğrenenin bilme sürecine gelme aşamalarını açıklar. Bu teorinin içsel olarak oluşturulma, objektif olmama, sosyal temelli olma gibi özellikleri bulunmaktadır (Fosnot, 1996).

Oluşturmacı yaklaşımın davranışcılık ve bilişselcilikten gelen farklı boyutları bulunmaktadır. Davranışcılara göre bilgi pasiftir ve öğrenme dış faktörler aracılığıyla gerçekleşir, bilişselcilere göre ise bilgi soyut sembolik gösterimler aracılığıyla insan zihninde oluşan bir süreçtir. Bilginin bir kişiden diğerine transferi ve kişiye özgü olarak bireysel olarak oluşturulması oluşturmacı yaklaşımın özelliklerindendir ve bu yönleriyle davranışçılık ve bilişselcilikten ayrılmaktadır (CSCL,1999).

Oluşturmacı yaklaşım disiplinler arası bir görüşe sahiptir ve psikolojik, felsefik, sosyolojik ve kritik eğitim teorilerinin sentezinden oluşmuştur. Eğitim açısından oluşturmacı yaklaşım, öğretmenin gücünden çok öğrenme sürecinde öğrenenin gücüne vurgu yapar (Thanasoulas, 2002).

İlköğretim düzeyinde oluşturmacı yaklaşım genellikle öğretim yolu, metodolojisi olarak algılanmaktadır. Bu yaklaşım herhangi bir öğretim programına uyarlanıp öğretmen adayları ve öğretmenler tarafından farklı okul dinamikleri göz önünde bulundurularak uygulanabilir. Öğrenenlerin bireysel öğrenmelerine ne denli önem verilirse o denli oluşturmacı öğretim yapılıyor demektir (Selley, 1999).

Öğrenci merkezli öğretim ve program ilk olarak fen öğretimi açısından 2000 Fen Bilgisi Öğretim Programında ortaya koyulmuştur. Bu programın yaklaşımına göre öğretmen öğrencilerine sadece bilgiyi aktaran değil aynı zamanda da onlarla birlikte öğrenen kişidir. Öğrencinin rolü ise programda kendi kendine keşif yoluyla öğrenen olarak tanımlanmıştır (MEB, 2000).

Dört yıl sonra değişen 2004-2005 Fen ve Teknoloji Öğretim Programının felsefesi oluşturmacı öğrenme yaklaşımıdır. Fen ve Teknoloji Öğretim Programı'nın temel anahtar noktaları şunlardır;

- Az bilgi özdür
- Program tüm fen ve teknoloji okur yazarlığı boyutlarını kapsamaktadır.
- Program, Oluşturmacı Öğrenme Yaklaşımını temel alarak oluşturulmuştur.
- Programda Oluşturmacı Öğrenme Yaklaşımına uygun ölçme ve değerlendirme yaklaşımları kullanılması öngörülmüştür.
- Öğrencilerin bilişsel ve duyuşsal gelişimleri programda gözetilmiştir.
- Programın yapısı sarmal yaklaşımla ele alınmıştır.
- Programda disiplinler arası yaklaşımın önemi vurgulanmıştır.

Fen Programlarındaki değişiklikler hizmet öncesi öğretmen eğitimini de etkilemiştir. Öğretmenlerin öğretme yeterlikleri, planlama ve karar verme süreçleri öğrenme ve öğretme ortamlarına şekil vermiştir. Bir tarafta teoriye dayalı eğitim diğer tarafta teoriyle pratiğin bütünleştirilmesi ve diğer kurumlarla işbirliği süreci. İkinci yöndeki eğilim yapılandırmacı öğrenme yaklaşımının öğretmen eğitiminde kullanılması gerektiğini vurgulamakta ve dünyada da bu eğilime doğru ilerlenmektedir (Beck ve Kosnik, 2006). Bu durum da ilköğretim düzeyindeki gelişmelerin öğretmen eğitimiyle paralel gittiğinin bir göstergesidir.

1.2. Önem

Oluşturmacı öğrenme ortamlarının etkisini test eden pek çok araştırma olmasına rağmen Akar (2003) öğretmen eğitiminde ülkemizde oluşturmacı yaklaşımın etkisini ölçmeye yönelik pek fazla çalışma bulunmadığını ve bu alanda yapılacak çalışmaların öğrenme ve öğretme ortamlarının düzenlenmesi konusunda büyük katkı sağlayacağını vurgulamaktadır.

Oluşturmacı öğrenme yaklaşımının fen öğretmen eğitiminde bilimsel süreç becerileri, fen öğretimine karşı tutum, ders başarısı gibi değişkenler açısından incelenmesinin değişik açılardan yararı bulunmaktadır.

Beck ve Kosnik (2006) öğretmen eğitiminde farklı öğretim metotlarının farklı değişkenlerle karşılaştırılmasına yönelik araştırmalar yapmanın öğretmen eğitim programlarının zenginleştirilmesi açısından önemli katkıları olduğunu öngörmektedir. Fosnot (1996) a göre öğretimdeki anlayıştaki farklılıklar mutlaka uygulama ortamlarına yansıtılmalıdır.

Öğrenme öğretme süreçlerinde yansıtıcı, oluşturmacı öğretmen tanımını yapmak öğretim programının yeniden düzenlenmesi için önerilerde bulunmak için teorik bilgi paylaşımının yanında alanda uygulamalı çalışmalar yapılması eğitimciler ve program geliştirme uzmanları açısından oldukça anlamlı olacaktır.

Fen öğretmen eğitimi alanında yapılan bu çalışma ilköğretim Fen ve Teknoloji eğitimindeki bulguların teyit edilip bütünleştirilmesi açısından anlamlı olacaktır. Araştırmanın sonucunda hem ilköğretim hem de öğretmen eğitimi düzeyinde önerilere yer verilmiştir.

Bu araştırma oluşturmacı öğrenme yaklaşımın farklı disiplinlerdeki uygulamalarını görmek ve diğer disiplinlerle karşılaştırmak açısından da önem taşımaktadır. Araştırma sonucunda günümüz bilgi çağının gerektirdiği tipte insan yetiştirme yolunda bilgi yerine beceri temelli öğretim kapsamında önerilerde bulunmuştur.

Araştırma sonucunda öğretmenlerin inançları, planlama ve karar verme süreçleriyle de ilgili olarak önemli ipuçlarına ulaşılmıştır. Herkesin bildiği gibi öğretmen inançları sınıf ve öğrenme ortamlarını düzenleme açısından önemli bir faktördür.

Özetle Türk eğitim sisteminde öğretmen eğitimi basamağında oluşturmacı öğrenme yaklaşımının etkilerini tespit etmeye yönelik yapılmış araştırmalara gereksinim duyulmaktadır. Araştırmanın önemi oluşturmacı öğrenme yaklaşımının eklektik yapısının öğretmen adaylarının öğrenci merkezli stratejileri kullanma, programı yorumlama anlamında gelecek araştırmalara ışık tuttuğu düşünülmektedir.

2. Literatür Taraması

Bu bölüm temel olarak iki kısımdan oluşmaktadır. Birinci bölümde oluşturmacılığın anlamı, oluşturmacı öğrenme ve öğretme yaklaşımları, öğretmen ve öğrencinin oluşturmacı yaklaşımda rolü ve oluşturmacılığın sınıf içi uygulamaları, ikinci bölümde ise oluşturmacı yaklaşımla ilgili yapılmış araştırmalar yer almaktadır.

2.1. Oluşturmacılığın Tarihsel Temelleri

Bir teori olarak oluşturmacılığın temel iki tarihsel kaynağı bulunmaktadır. Bunlardan bir tanesi felsefi bir akım olarak eğitim teorileri ve uygulamalarının oluşumu diğeri ise alandaki uygulamacı ve öğretmenlerin deneyimi sonucunda elde edilen bilgilerdir.
Felsefi alandaki temeller Plato, Sokrates, modern zamanlarda Immanuel Kant tarafından ele alınmıştır.

Oluşturmacı yaklaşımın okullardaki uygulamaları yakın tarihte John Dewey tarafından ilerlemeci okullar yardımıyla açıklanmaya çalışılmıştır. İlerlemeci okul tanımında öğrencilerin kendi öğrenmelerinden kendilerinin sorumlu olduğu ve öğretmenlerin öğrencilerin kendi öğrenme ortamlarını yaratmalarına fırsat tanıdıkları anlatılmaktadır.

Oluşturmacı yaklaşımın tarihsel süreci incelendiğinde bu yaklaşımın insan ve toplum için kullanılmaya başlandığı ve günümüzde eğitim alanındaki uygulamalarının arttığı sonucuna ulaşılabilir.

2.2. Oluşturmacı Öğretme Yaklaşımları

Eğer öğrenci öğrenme ortamına kendi dünyasında var olan birtakım görüşlerle birlikte geliyorsa öğretme ortamının bu görüşlerle etkileşim içinde olması gerekir. Öğrenenlerin bazıları bir kavrama bilim insanı detaycılığıyla yaklaşırken diğerleri konunun uygulama ve kişisel boyutuyla ilgilenebilir. Ezbere dayalı öğretim geleneksel fen sınıflarının birer getirisi haline gelmektedir. Bu nedenle öğrenme ve öğretim metotlarıyla ilgili yapılan çalışmalar yeni öğrenmeler için daha iyi birer temel oluşturabilecektir. Anlam ve öğrenmenin doğasıyla ilgilenme, fenle ilgili iyi bir imaj oluşturabilecektir.

Fen öğretiminin oluşturmacı öğrenme yaklaşımıyla ele alınmasıyla ilgili dört durum bulunmaktadır. Bunlar;

1. Oluşturmacı perspektife göre yanlıca tek bir doğru metot ya da öğretim kuralı yoktur.
2. Fen öğretimi yalnızca yeni kavramsal yapılarla ilgilenmez, aynı zamanda bilgiye yeni bir bakış açısı getirir.
3. Fen öğretimi deneysel bulgularla gelişir ve toplumun ihtiyaçlarına göre şekillenir.
4. Oluşturmacı yaklaşımla öğretim etkinliklerin hem uygulamalı boyutunu hem de bunların tartışıp öğrenciler tarafından yorumlanması sürecini içinde barındırır.

Oluşturmacı yaklaşıma göre öğretimde öğretmenin rolü büyük önem taşımaktadır. Öğretmen inançları ve rolleri öğrenme ortamını şekillendirmektedir. Bu nedenle oluşturmacı öğrenme ortamlarında oluşturmacı ve deneyimli öğretmenlerin tanımına ihtiyaç bulunmaktadır.

2.3. Oluşturmacı Öğrenme ve Öğretme Ortamlarında Öğretmenin Rolleri

Yeni donanımlı ve deneyimi az olan bir öğretmen içeriği kitaplar gibi yazılı basılı kaynaklardan seçmek yerine öğrencinin ihtiyaçlarını göz önünde bulundurarak ele alır. Aşağıda verilen maddeler öğrenme ortamlarının her aşamasında gerçekleştirilebilir;

- Geçmişte öğrencinin nelere ilgi duyduğunun göz önünde bulundurulması
- Herhangi bir performans görevine dayalı olarak öğrencilerin hangi becerileri kazandığı ve hangilerini geliştirmeleri gerektiğinin farkında olunması,

Yager (1991) oluşturmacı öğrenme modeline göre öğretmenlerin takip ettikleri prosedürleri aşağıda belirtmiştir;

- Derslere ve programdaki tüm konuların işlenişine yön vermede öğrenci sorularını göz önünde bulundurma,
- Öğrenci fikirlerini onaylama ve onları cesaretlendirme
- Öğrenme sürecinin birer ürünü olan öğrenci liderliği, işbirliği, bilginin yerleşimi ve uygulanması süreçlerini geliştirme
- Öğrencinin düşünceleri, deneyimleri ve ilgi alanlarını dersleri yönlendirmede işe koşma,
- Uzmanlardan ya da farklı kaynaklardan elde edilen bilginin farklı türlerini kullanmaya teşvik etme
- Açık uçlu sorular kullanarak öğrencinin aynı zamanda kendi soruları ve cevapları üzerinde düşünmelerini sağlama
- Öğrencinin olayların neden-sonuç ilişkileri üzerinde düşünmelerini sağlama
- Öğrencilerin kendi fikirlerini sınamaları, gelecekteki olayların sonuçlarını tahmin etmeleri için teşvik etme
- Kitabi bilgiler ya da öğretmen görüşlerini ifade etmeden önce öğrencinin görüşlerini sınıf ortamında değerlendirme
- Öğrencileri, başkalarının fikirleri üzerinde düşünmeleri yönünde cesaretlendirme

- Bireylerin fikirlerine saygı duyan işbirliğine dayalı öğrenme stratejilerini kullanma
- Sınıf ortamlarında yansıtma ve analiz için zaman ayırma. Öğrencileri öz değerlendirme yapmaya, görüşlerini kanıtlamaya yardımcı olacak deliller toplamaya teşvik etme.

2.4. Sınıf Ortamlarında Oluşturmacılık

Oluşturmacı öğrenme ortamlarında öğrenciler öğrenme sürecine aktif olarak katılarak bilginin yeniden oluşturulması, anlamlı bir şekilde düzenlenmesi ve deneyimlendirilmesi sürecinde bulunurlar. Bu süreçte öğretmenler süreçte otoriteden ziyade rehber durumundadırlar. Sınıf ortamlarında işbirliğine dayalı grup etkinliklerinin yapılması yönünde teşvik edilir.

Yager (1991) fen sınıflarında oluşturmacı öğrenme ortamının etkili bir şekilde işe koşulması için on temel nokta üzerinde durmuştur;

- Öğrencilerin belirledikleri problem durumlarını sınıf ortamlarında düzenleyici olarak işe koşma
- Problemlerin çözümünde insan ve materyal gibi yerel kaynakları kullanma
- Günlük yaşamdaki problemlerin çözümü için önerilerde bulunma sürecine öğrencileri dahil etme
- Öğrenmeyi sınıf ve okul dışına çıkarma
- Fenin her bir birey üzerindeki etkisini inceleme
- Fen içeriğinin öğrencilerin test ortamlarında gördüklerinden daha farklı olduğunu vurgulama
- Süreç becerilerini yeniden vurgulayarak bu becerilerin bilim insanları tarafından kullanıldığını vurgulama
- Kariyer farkındalığına vurgu yapma-özellikle fen ve teknolojiyle ilgili kariyerlerde
- Vatandaş olarak öğrenciler için toplumsal sorunlara çözüm bulmada imkanlar sağlama,

- Fen ve teknolojinin geleceği etkileyecek temel öğeler olduğunu gösterme

2.5. Oluşturmacılık ve Öğretmen Eğitimi Programları

Yager (1991) e göre, Oluşturmacı Öğrenme Modelinin başarılı etkileri olması için fen öğretmen eğitiminin üzerinde durulması gereklidir. Öğretmen eğitimi çoğu zaman etkili bulunmadığı için eleştiri konusu olmuştur. Eğer öğrencilerin nasıl öğrendikleri konusunda fikir sahibi olursak öğretmen eğitiminde de alanında başarılı öğretmenler yetiştirebilmek adına önemli ipuçlarına sahip olmuş oluruz.

Oluşturmacı modelin kullanıldığı fen öğretmen eğitimi programlarında aşağıdaki özellikler bulunmalıdır;

- Programlar genel olarak kolej tabanlı yerine okul tabanlarıdır ve karmaşık becerilerle doğrudan ilgilendiğinde daha etkili sonuçları olacaktır.
- Öğretmenler planlama sürecinde aktif olarak yer alır.
- Bireysel olarak öğretimin planlanması gündeme gelir.
- Bireyselleştirilmiş öğretim akran gruplarına göre yapılan öğretimden daha etkilidir.
- Öğretmenler programda pasif yerine sürekli aktif rol oynarlar.
- Programlar gösterimler, denemeler ve geri bildirimler üzerine kuruludur.
- Öğrenciler, öğretmenler ve liderler sürekli paylaşım içindedir.
- Programlar okulun felsefesi ve gayretleriyle ilgilidir.

2.6. Oluşturmacılık İle İlgili Araştırmalar

Bu bölümde oluşturmacı temelli öğretim stratejilerinin fen eğitiminde kullanımı, fen öğretmen eğitimi, oluşturmacı temelli ölçme ve değerlendirme etkinliklerinin fen eğitiminde kullanımı, fen okuryazarlığı, bilimsel süreç becerileri, öğretmen düşünce, karar verme ve planlama süreçlerinin fen eğitimi ve oluşturmacılık açısından önemi açısından araştırmalar ele alınmıştır.

2.6.1. Oluşturmacı Öğretim Stratejilerinin Fen Eğitiminde Kullanımıyla İlgili Araştırmalar

Leach ve diğerleri (2005) kısa süreli öğretim uygulamalarının feni öğretme ve öğrenmedeki etkisini araştırmışlardır. Araştırma grubu 3 biyoloji, 3 fizik ve 3 kimya olmak üzere toplam 9 öğretmenden oluşmaktadır. Bu öğretmenlerle yaşları 11 ile 15 arasında değişen öğrencilere 3 öğretim süreci planlamaları istenmiştir. Bulgular süreç temelli kritik düşünme sorularının öğrencilerin motivasyonlarını arttırdığı ve fen eğitimiyle ilgili öğrencilerin düşüncelerini olumlu yönde değiştirdiğini göstermektedir.

Davies (2003) öğretmenlerin ön deneyimleri ve inançlarının ders planlama süreçlerini etkileyip etkilemediğini araştırmıştır. Araştırma kapsamında Londra'daki Goldsmith Kolejindeki 126 öğretmen adayıyla çalışılmış ve anket sorularına verdikleri cevaplar onların fen, teknoloji, toplum ve bunun programdaki ilişkileri hakkındaki inançlarını belirlemek amacıyla hazırlanmıştır. Sonuçlar, sağlam bir teorik altyapıya sahip olmadan ve kavramlar arasında ilişki kurmadan öğretmenlerin etkili uygulamalar yapamayacağını göstermektedir.

2.6.2. Fen Öğretmen Eğitimiyle İlgili Araştırmalar

Akcay (2007) Fen-Teknoloji-Toplum dersinin fen öğretmen adayları üzerindeki etkisini belirlemeye yönelik bir doktora tez çalışması gerçekleştirmiştir. Ders oluşturmacı öğrenme ortamının fen öğretmen adayları üzerindeki etkilerine odaklanmıştır. Araştırma kapsamında nitel ve nicel araştırma yöntemleri bir arada kullanılmıştır. Araştırma, tek gruplu ön test-son test desenidir. Araştırmada kullanılan ölçme araçları öğretmen adaylarına sürecin başında öntest, sonunda ise sontest olarak uygulanmıştır. Örneklem, 2004-2005 öğretim yılında Iowa Üniversitesi'nde Biyolojik Kavramların Eğitim Uygulamaları dersini alan 41 öğretmen adayıdır.

2.6.3. Fen Eğitiminde Oluşturmacı Değerlendirme Tekniklerinin Kullanılmasına Yönelik Araştırmalar

Cowie (2005) öğrencileri fen sınıflarında değerlendirme yöntem ve teknikleri hakkındaki görüş ve düşüncelerini belirlemeye yönelik görüşmeler ve sınıf içi gözlemler yürütmüştür. Araştırmanın sonuçları toplumsal sorumlulukların öğretmen öğrenci arasındaki ilişkilerin öğrencilerin sınıf içi algıları ve deneyimleri tarafından belirlendiği sonucuna ulaşılmıştır.

2.6.4. Fen Eğitiminde Fen Okuryazarlığı ve Oluşturmacı Yaklaşımla İlişkisine Yönelik Araştırmalar

Kim (2005) düşünce sistemi ve günümüzdeki fen eğitimiyle ilgili araştırmasında fen eğitimine teorik açıdan bakmış ve bilişim sistemleri açısından doğurgularını incelemiştir. Bu bir felsefi ve teorik araştırmadır ve üç bölümden oluşmaktadır: Birinci bölümde 20. yüzyılda fen eğitiminde popüler olan öğeler, ikinci bölümde ise sistem düşüncesinin doğası tartışılmıştır. Son bölümde ise sistemli düşünme paradigmasının fen eğitimi açısından getirileri ele alınmıştır. Araştırmada şu sonuçlar elde edilmiştir; i) fen okuryazarlığı bilgi çağında fen eğitimi açısından en önemli öğelerden biridir, ii) şu andaki sistem düşüncesi analitikten sistematiğe doğru geçmektedir, iii) sistem düşüncesi uygulama boyutunda fen okuryazarlığının gerekli bir formu olarak saptanmıştır.

2.6.5. Bilimsel Süreç Becerilerinin Fen Eğitiminde Kullanılmasına Yönelik Araştırmalar

Scherz ve diğerleri (2005) üst düzey düşünme becerilerinin tanımlanmasına yönelik bir program geliştirmiş ve bu programı birinci sınıf lise öğrencileri üzerinde uygulamıştır. Araştırma 447 öğrenciden oluşmaktadır. Bunlardan 334'ünü deney grubu öğrencileri oluşturmakta, kontrol grubunda ise 113 öğrenci yer almaktadır. Deney grubunda üst düzey düşünme becerilerini geliştirmeye yönelik program uygulanmıştır, kontrol grubunda ise geleneksel öğretim metoduyla dersler işlenmiştir. Araştırmanın sonuçları deney grubu öğrencilerinin performansının üst düzey düşünme becerilerini tanımlama ve uygulama, karmaşık görev durumlarının üstesinden gelme açısından yüksek olduğu sonucuna ulaşılmıştır.

2.6.6. Öğretmen Düşünme, Karar Verme ve Planlama Süreçleriyle İlgili Araştırmalar

Seroussi (2005) öğretmenlerin algılarıyla sorgulama odaklı öğretimi planlama becerileri arasındaki ilişkileri yoklamaya yönelik araştırma planlamıştır. Araştırma soruları i) öğretmenler sorgulama temelli öğretimi nasıl algılamakta ve uygulamaktadırlar ii) öğretmenin öğrencilerin öğrenmesi hakkındaki yorumlamaları onların ders planlamalarını ne şekilde etkilemektedir, şeklindedir. Araştırmaya altı fren bilgisi öğretmeni ve onların yedinci sınıf ile on ikinci sınıf düzeyinde değişen öğrencileri araştırmaya katılmışlardır. Araştırmada nitel ve nicel araştırma yöntemleri bir arada kullanılmıştır. Araştırmada kullanılan anket, sınıf içi gözlemler ve öğretmenlerle yapılan görüşmeler anlamlı kategori ve kodlar altında toplanarak betimsel analiz ve içerik analizine tabi tutulmuştur. Araştırmanın sonuçları, sorgulamaya dayalı öğretimin öğretmenlerin pedagojik uygulamalarına dayalı olduğunu göstermektedir. Araştırmanın bir diğer bulgusu da öğrencilerin sınıf içerisinde olanlarla ilgili olarak pek fazla bir şey söylemedikleridir.

2.6.7. Türkiye’de Yapılan Araştırmalar

Kesal ve Aksu (2005) oluşturmacı öğrenme ortamlarına ilişkin İngilizce Dil Öğretimi dersi alan öğrencilerin algılarını belirlemeye yönelik araştırma yapmışlardır. İngilizce Dil Öğretimi alan 410 öğrenci araştırmanın çalışma grubunu oluşturmaktadır. Araştırmanın sonuçları öğrencilerin büyük çoğunluğunun öğrenme ortamlarını oluşturmacı olarak algıladıklarını göstermektedir. Öğrencilerin bulundukları üniversite ve ders notları algılarını etkilerken cinsiyet ve lise geçmişleri algılarında önemli bir rol oynamamıştır.

Önal (2005) yüksek lisans tez çalışmasında, performans dayanaklı değerlendirmenin öğrencilerin bilimsel süreç becerilerine etkisini incelemiştir. Araştırmanın örneklemini 36 deney grubu 36 kontrol grubunda olmak üzere toplam 72 yedinci sınıf öğrencisi oluşturmaktadır. Araştırmacı tarafından geliştirilen Bilimsel Süreç Becerileri Testi ve literatürden alınan Fen Bilgisi Tutum Ölçeği öğrencilere süreç başı ve sonunda uygulanmıştır. Araştırmada ön test-son test kontrol gruplu yarı deneysel desen kullanılmıştır. Araştırmadaki nicel bulgular yanında sınıf içi gözlemler, öğretmen ve öğrenci görüşmeleri gibi nitel veriler de toplanmıştır. Araştırmanın sonuçları fen sınıflarında performans dayanaklı değerlendirme uygulamalarının bilimsel süreç becerileri ve fen bilgisine karşı tutum üzerinde olumlu etkisi olduğunu göstermektedir.

3. Yöntem

Bu bölümde araştırma deseni, araştırma soruları, hipotezler, araştırmada kullanılan değişkenler, uygulamanın tanıtılması, kapsam, katılımcı özellikleri, veri toplama araçları, veri toplama süreci, verilerin analizi, sayıtlılar, sınırlılıklar ve güç analizi gibi bölümler yer almaktadır.

3.1. Araştırma Deseni

Oluşturmacı öğretimin fen bilgisi öğretmen adaylarının bilimsel süreç becerileri, fen öğretimine karşı tutum, ders başarısı gibi değişkenler açısından etkisini araştırmak amacıyla bu araştırmada ön test son test kontrol gruplu yarı deneysel desen kullanılmıştır. Araştırmada yarı deneysel desen kullanıldığından katılımcıların evrenden tesadüfi atama yoluyla belirlenme durumu bu araştırma için sağlanamamıştır.

Araştırmada deney grubunda uygulanan oluşturmacı öğretim bağımsız değişken öğretmen adaylarının bilimsel süreç becerileri, fen öğretimine karşı tutumları, ders başarıları ve bu üç değişkenin kalıcılıkları araştırmanın bağımlı değişkenleri olarak belirlenmiştir.

Araştırma devlet üniversitelerinden birinde Eğitim Fakültesi Fen Bilgisi Eğitimi Anabilim Dalı'nda öğrenim görmekte olan ve Özel Öğretim Yöntemleri II dersini alan 103 dördüncü sınıf Fen Bilgisi öğretmen adayıyla gerçekleştirilmiştir. Araştırma 2007-2008 Güz Dönemi'nde gerçekleştirilmiş olup toplam 15 hafta sürmüştür.

Araştırmanın deney grubunda 53, kontrol grubunda 50 öğrenci bulunmaktadır ve bu öğrenciler dönem başında Öğrenci İşleri tarafından 01 ve 02 şubeleri olarak belirlenmiştir. Deney ve kontrol gruplarının denkliğini sağlamak amacıyla deney ve kontrol grupları arasında ön test puanları açısından anlamlı bir fark olup olmadığı t-testi aracılığıyla kontrol edilmiş ve iki grup arasında anlamlı bir fark bulunmadığı tespit edilmiştir.

Araştırma Eylül 2007'nin üçüncü haftasında başlamış olup Ocak 2008 ayının son haftasına kadar devam etmiştir. Özel Öğretim Yöntemleri II dersine toplam 15 hafta ve haftada 4 saat olmak üzere deney grubunda 60 ve kontrol grubunda 60 saat uygulama yapılmıştır. Özel Öğretim Yöntemleri II dersi temel olarak iki bölümden oluşmaktadır.

Dersin teorik bölümü yedi üniteden oluşmaktadır: Fen ve Teknoloji Programının Genel Felsefesi ve Özellikleri, Fen Öğretiminde Probleme Dayalı Öğrenme, Fen Öğretiminde Proje Tabanlı Öğrenme, Fen Eğitiminde Sınıf Dışı Etkinlikler Tasarlama, Fen Eğitiminde Kavram Öğretimi, Fen Eğitiminde Yaratıcı Drama Uygulamaları. Araştırma öncesinde her iki gruptaki öğretmen adaylarına ön Bilimsel Süreç Becerileri Testi (ÖNBSBT), Fen Öğretimine Karşı Tutum Ölçeği (ÖNFÖKTÖ) ve Başarı Testi (ÖNBT) uygulanmış, araştırmanın sonunda yani sürecin başlangıcından 15 hafta sonra son Bilimsel Süreç Becerileri Testi (SONBSBT) , Fen Öğretimine Karşı Tutum Ölçeği (SONFÖKTÖ) ve Başarı Testi (SONBT) uygulanmıştır. Son testlerin uygulanmasından 10 hafta sonrasında üç test için kalıcılık testleri uygulanmıştır (KALBSBT, KALFÖKTÖ ve KALBT).

Araştırmanın başlangıcı ve sonrasında deney ve kontrol gruplarına öğretmen adaylarının süreçle ve genel olarak fen eğitimiyle ilgili algılarını belirlemeye yönelik açık uçlu sorulardan oluşan anket uygulanmıştır. Yine araştırma sırasında ve araştırmanın sonunda anket sorularına verdikleri yanıtlar ve ders başarıları göz önünde bulundurularak deney ve kontrol grubundan seçilen toplam 12 öğretmen adayıyla odak grup görüşmeleri yürütülmüştür.

3.2. Araştırma Soruları

Araştırmanın amacı, oluşturmacı temelli öğretimin dördüncü sınıf fen bilgisi öğretmen adaylarının bilimsel süreç becerileri, fen öğretimine karşı tutum ve ders başarıları ile kalıcılıkları üzerine etkisini incelemektir. Buna göre araştırma sırasında şu sorulara cevap aranmaya çalışılmıştır;

1. Oluşturmacı öğretim gören deney grubu fen öğretmen adaylarıyla geleneksel yöntemle ders işleyen fen öğretmen adayları arasında başarıları ve kalıcılık puanları açısından anlamlı bir fark var mıdır?
2. Oluşturmacı öğretim gören deney grubu fen öğretmen adaylarıyla geleneksel yöntemle ders işleyen fen öğretmen adayları arasında fen öğretimine karşı tutum ve kalıcılık puanları açısından anlamlı bir fark var mıdır?
3. Oluşturmacı öğretim gören deney grubu fen öğretmen adaylarıyla geleneksel yöntemle ders işleyen fen öğretmen adayları arasında bilimsel süreç becerileri ve kalıcılık puanları açısından anlamlı bir fark var mıdır?
4. Oluşturmacı öğretim gören deney grubu fen öğretmen adaylarıyla geleneksel yöntemle ders işleyen fen öğretmen adaylarının sürece ilişkin algıları nelerdir?

3.3 Hipotezler

Araştırma soruları doğrultusunda belirlenen hipotezler yokluk hipotezi formatında aşağıda belirtilmiştir;

Yokluk Hipotezi 1.1. Oluşturmacı temelli öğretim gören deney grubu fen öğretmen adaylarıyla geleneksel yöntemle ders işleyen fen öğretmen adayları arasında son başarı puanları açısından anlamlı bir fark yoktur.

Yokluk Hipotezi 1.2. Oluşturmacı temelli öğretim gören deney grubu fen öğretmen adaylarıyla geleneksel yöntemle ders işleyen fen öğretmen adayları arasında kalıcılık başarı puanları açısından anlamlı bir fark yoktur.

Yokluk Hipotezi 2.1. Oluşturmacı temelli öğretim gören deney grubu fen öğretmen adaylarıyla geleneksel yöntemle ders işleyen fen öğretmen adayları arasında son fen öğretimine karşı tutum puanları açısından anlamlı bir fark yoktur.

Yokluk Hipotezi 2.2. Oluşturmacı temelli öğretim gören deney grubu fen öğretmen adaylarıyla geleneksel yöntemle ders işleyen fen öğretmen adayları arasında kalıcılık fen öğretimine karşı tutum puanları açısından anlamlı bir fark yoktur.

Yokluk Hipotezi 3.1. Oluşturmacı temelli öğretim gören deney grubu fen öğretmen adaylarıyla geleneksel yöntemle ders işleyen fen öğretmen adayları arasında bilimsel süreç beceri puanları açısından anlamlı bir fark yoktur.

Yokluk Hipotezi 3.2. Oluşturmacı temelli öğretim gören deney grubu fen öğretmen adaylarıyla geleneksel yöntemle ders işleyen fen öğretmen adayları arasında kalıcılık bilimsel süreç beceri puanları açısından anlamlı bir fark yoktur.

3.4. Araştırma Verilerinin Tanımlanması

Araştırmada dört tane değişken kullanılmıştır. Bunlardan bir tanesi bağımsız değişken diğer üçü ise bağımlı değişkenlerdir.

Bağımsız Değişken: Uygulama (Öğretim Metodu): Yager (1991) ın geliştirdiği Oluşturmacı Öğrenme Modeline göre geliştirilen uygulama

Bağımlı Değişkenler: a) Son ve kalıcılık ders başarıları, b) Son ve kalıcılık fen öğretimine karşı tutumları c) Son ve kalıcılık bilimsel süreç becerileri

3.5. Yager (1991) in Oluşturmacı Öğrenme Modeline Göre Geliştirilen Oluşturmacı Öğretim

Araştırmada deney grubunda uygulanan tüm etkinlikler Yager (1991) tarafından geliştirilen Oluşturmacı Öğrenme Modeli doğrultusunda tasarlanmıştır. Bu modele göre ilk adım davet adımıdır. Sürecin başlangıcında öğretmen öğrencilerin ön öğrenmelerini belirlemek ve açığa çıkarmak amacıyla kritik düşünme soruları sorar. İkinci adım araştırma, keşfetme olarak tanımlanır. Bu adımda öğrenciler belli bir soru üzerinde geçmiş bilgilerini işe koşarak tartışma yaparlar. Üçüncü adım açıklamalar ve çözüm önerileri sunmadır. Bu aşamada her grup kendi fikrini söyler ve sonunda öğretmen gruplardan gelen tüm bilgileri bütünleştirerek dersin amaçları doğrultusunda bir senteze varır. Dördüncü ve son basamak ise uygulamaya geçmedir. Bu aşamada öğrenci edindiği bilgileri nasıl uygulamaya aktarıp günlük yaşamda kullanacağı üzerine fikir yürütür.

3.6. İçerik

Özel Öğretim Yöntemleri II dersi Eğitim Fakültelerinde Fen Bilgisi Öğretmen Adaylarına dördüncü sınıfın ilk döneminde verilen bir derstir. Bu dersin ön koşulu fen bilgisi öğretmen adaylarının üçüncü sınıf ikinci dönemde aldıkları Özel Öğretim Yöntemleri I dersidir. Bunun öncesinde fen bilgisi öğretmen adayları birinci sınıfta Öğretmenlik Mesleğine Giriş, Okul Deneyimi I derslerini, ikinci sınıfta Öğrenme Psikolojisi ve Öğretimi Planlama ve Değerlendirme derslerini, üçüncü sınıfta ise Sınıf Yönetimi ve Özel Öğretim Yöntemleri I derslerini alırlar.

Özel Öğretim Yöntemleri II dersinin sonunda öğrenciler;

1. Fen ve Teknoloji Programının genel felsefesini ve programla ilgili temel özellikleri anlarlar.

2. Fen öğretiminde kullanılan farklı yaklaşım, yöntem ve teknikleri kavrarlar.
3. Fen öğretiminde etkili öğrenme ortamları geliştirir ve uygularlar.
4. Fen öğrenme ve öğretme sürecinde sosyal etkileşim ve grup çalışmalarının önemini kavrar.
5. Hem öğrenme öğretme hem de ölçme ve değerlendirme süreçleriyle ilgili doküman geliştirirler.

3.7. Oluşturmacı Ders Planları

Araştırma sürecinde kullanılan ders planları oluşturmacı yaklaşıma göre öğrenci merkezli yaklaşım, yöntem ve teknikler kullanılarak araştırmacı tarafından süreç başında hazırlanmış olup Oluşturmacı Öğrenme Modeli'nin özelliklerini anlatan ölçüt tablosu ve soruları alandaki iki uzmana verilerek içerik geçerliği için uzman kanısı alınmıştır. İçerik ve dil konusunda bu doğrultuda düzenlemeler yapılmıştır. Ayrıca araştırmada kullanılan ders planları beş hafta sürecinde 50 ikinci sınıf fen bilgisi öğretmen adayına uygulanmış, süreç sonu ve başında tutum, bilimsel süreç becerileri ve başarıları karşılaştırılmıştır.

3.8. Öz Değerlendirme, Sunuş Gözlem ve Grup Değerlendirme Formları

3.8.1. Öz Değerlendirme Formu

Bu formda öğretmen adaylarının kendilerini fen eğitimiyle ilgili çalışmalar sürecinde nasıl algıladıklarına ilişkin 14 tane ifade bulunmaktadır. Bu form 15 mezun, 132 mezun olmayan toplam 147 fen bilgisi öğretmen adayına uygulanmıştır. Formun güvenirlik katsayısı 0.86 olarak tespit edilmiş ve formun içeriği ve dilin iki uzmanın görüşleri doğrultusunda yeniden düzenlenmiştir.

3.8.2. Grup Değerlendirme Formu

Bu formda öğretmen adaylarının kendilerini ve grup arkadaşlarını fen eğitimiyle ilgili grup çalışmalarında nasıl algıladıklarını tespit etmeye yönelik 17 önerme bulunmaktadır. Bu form 168 hizmet öncesi fen bilgisi öğretmen adayıyla 15 mezun fen bilgisi öğretmen adayına uygulanmış ve güvenirlik katsayısı 0.91 olarak hesaplanmıştır. Form, içerik ve dil açısından pilot çalışma ve iki uzmanın görüşleri doğrultusunda yeniden düzenlenmiştir.

3.8.3. Sunuş Gözlem Formu

Bu form genel olarak öğrenme öğretme sürecinin hazırlığı, düzenlenmesi, ölçme ve değerlendirme süreciyle ne derecede yapılandırmacı olduğuna dair özellikleri içerisinde barındırmaktadır. Sunuş Gözlem Formu hem deney hem de kontrol grubunda uygulama sürecini kanıtlama amacıyla kullanılmıştır. Pilot çalışma için iki uzman görüşü ve 15 mezun fen bilgisi öğretmeninin uygulama ve görüşleri alınarak form yeniden düzenlenmiştir.

3.9. Katılımcılar

Araştırma, bir devlet üniversitesinde Eğitim Fakültesi Fen Bilgisi Eğitimi Anabilim Dalı'nda öğrenim görmekte olan 103 dördüncü sınıf öğrencisinden oluşmaktadır. Deney grubu 21 erkek 32 kız olmak üzere toplam 53 fen bilgisi öğretmen adayından; kontrol grubu ise 19 erkek 31 kız olmak üzere toplam 50 fen bilgisi öğretmen adayından oluşmaktadır. Araştırmaya toplam 40 erkek, 63 kız öğretmen adayı katılmıştır.

3.10. Veri Toplama Araçları

Araştırmada kullanılan ölçme araçları aşağıda belirtilmiştir;

3.10.1. Başarı Testi

Ders başarı testi araştırmacı tarafından uygulama sürecinin öncesinde geliştirilmiş olup toplam 10 açık uçlu sorudan oluşmaktadır. Bu testin pilot çalışması geçen yıl mezun olmuş 70 Fen Bilgisi öğretmeniyle gerçekleştirilmiştir. Ders başarı testi için belirtke tablosu ve dereceli puanlama anahtarı hazırlanmıştır. Testin kapsam geçerliği için biri fen eğitimi diğeri ise eğitim programları ve öğretim alanında uzman iki kişi tarafından incelenmiştir. Ayrıca ders başarı testi ön, son ve kalıcılık için araştırmacıyla birlikte fen eğitimi alanında uzman bir kişi tarafından dereceli puanlama anahtarı aracılığıyla puanlanmıştır. İki kişinin kodlamaları arasındaki korelasyon katsayısı 0.78 olarak tespit edilmiştir. Testin içeriğinde oluşturmacılıkla ilgili anahtar kavramlar, oluşturmacı öğrenme ortamının özellikleri, öğretmen ve öğrenci özellikleri, oluşturmacı ölçme ve değerlendirme yaklaşımları, probleme dayalı öğrenme senaryosunun özellikleri, proje tabanlı öğrenmede kullanılan ölçme ve değerlendirme yaklaşımları, sınıf içi ve dışı etkinlikleri hazırlarken göz önünde bulundurulması gereken kurallar, fen eğitiminde etkili kavram öğretimi, oluşturmacı öğrenme yaklaşımı sonucunda kazanılan beceriler bulunmaktadır.

3.10.2. Fen Öğretimine Karşı Tutum Ölçeği

Ölçek 11 pozitif 11 negatif madde olmak üzere toplam 21 maddeden oluşmaktadır. Fen Öğretimine Karşı Tutum Ölçeği ilk kez Thomson ve Shrigley tarafından geliştirilmiş olup Tekkaya ve Çakıroğlu (2002) tarafından Türkçe'ye adaptasyonu yapılmıştır. Ölçeğin güvenirlik katsayısı 0.83 olarak tespit edilmiştir. Daha sonra ölçek araştırmanın pilot uygulaması kapsamında 220 öğretmen adayına uygulanıp güvenirlik katsayısı 0.862 olarak saptanmıştır.

3.10.3. Bilimsel Süreç Becerileri Testi (BSBT)

Test araştırmacı tarafından yüksek lisans tezi sırasında geliştirilmiş olup fen konularıyla ilgili 36 maddeden oluşmaktadır. Sorular TIMSS 2003 taksonomisine göre geliştirilmiş olup tamamı beceri temelli sorulardan oluşmaktadır. Testin güvenirliği 0.89 olarak hesaplanmıştır. Bu araştırma için test 363 öğretmen adayına uygulanmış olup güvenirlik katsayısı 0.925 olarak tespit edilmiştir.

3.10.4. Anket

Öğretmen adaylarının sürece ilişkin algılarını belirleme amacıyla hazırlanmış olan anket araştırmacı tarafından geliştirilmiş olup yedi açık uçlu sorudan oluşmaktadır. Uygulamanın başında ve sonunda deney ve kontrol grubu katılımcılarına uygulanan anket; fen eğitimiyle ilgili iyi ve eksik hissedilen yönler, fen öğretiminde en çok tercih edilen yöntem, teknikler ve nedenleri, alanında başarılı bir fen öğretmeninin özellikleri, Özel Öğretim Yöntemleri II dersinin fen öğretimi açısından yeri ve önemi, Özel Öğretim Yöntemleri II dersinde fen öğretimi açısından olumlu ve geliştirilmesi gereken yönler, Özel Öğretim Yöntemleri II dersinden beklentiler ve ders sonunda kazanılan becerilerden oluşmaktadır. Anket soruları için biri fen eğitiminde uzman diğeri eğitim programları ve öğretim alanında uzman iki kişinin görüşü alınmış ve anket geçen yıl mezun olmuş 5 fen bilgisi öğretmenine pilot çalışma kapsamında uygulanmıştır.

3.10.5. Yarı Yapılandırılmış Görüşme Soruları

Bu sorular araştırmacı tarafından anket sorularından türetilmiş olup araştırma sırası ve sonrasında deney ve kontrol grubundan anketlere verdikleri cevaplar ve başarı durumları doğrultusunda seçilen toplam 12 öğretmen adayıyla odak grup görüşmeleri gerçekleştirilmiştir. Görüşme sorularının pilot çalışması geçen yıl mezun olmuş 5 fen bilgisi öğretmeniyle yapılmış olup dil ve kapsam geçerliği için fen eğitimi ve eğitim programları ve öğretim bilim dalında uzman iki kişinin görüşleri alınmıştır.

3.11. Veri Toplama Süreci

Gerekli izinlerin alınmasının ardından ön testler deney ve kontrol grubuna uygulanmıştır. Ardından 15 hafta sürecinde deney grubunda Yager (1991) Oluşturmacı Öğrenme Modeline göre geliştirilen ders planları uygulanmış, kontrol grubunda ise geleneksel öğretim metodu uygulanmıştır. Süreç başından sonuna kadar dersin öğretim elemanı tarafından izlenmiş olup 5 hafta boyunca farklı bir üniversiteden gelen fen eğitimcisi tarafından gözlemlenmiştir. İki grup arasındaki temel fark deney grubunda öğrenci merkezli aktiviteler ve grup çalışmaları yapılırken kontrol grubunda daha çok düz anlatıma dayalı aktiviteler yapılmıştır. Deney grubunda öğretmen yol gösterici ve motive edici konumda iken kontrol grubunda öğretmen otorite sahibidir. Hem deney hem de kontrol grubunda aynı içerik kullanılmıştır. Yalnız deney grubunda öğretmen adayları sunumları için kendi ölçütlerini geliştirmişler ve süreçte bireysel değerlendirme formu, grup değerlendirme formu ve sunuş gözlem formları kullanılmıştır.

3.12. Uygulamanın Doğrulanması

Bu süreç alandan iki fen eğitimcisinin yardımıyla gerçekleştirilmiştir. Bu kişilerden biri tüm süreci iki grupta gözlemlemiş, diğeri ise her iki grupta 5 hafta süresince gözlem yapmıştır. Gözlem formu, sınıf içinde alınan notlar ve öğretmen adaylarıyla görüşme sorularından elde edilen bilgiler uygulamanın doğrulanma sürecinde kullanılmıştır.

3.13. Veri Analizi

Araştırma sorularına göre bu araştırmada farklı veri analizi yöntemleri kullanılmıştır. İlk 3 soru için tekrarlayan verilerde varyans analizi son sorunun analizinde ise nitel analiz tekniklerinden betimsel analiz ve içerik analizi tekniği kullanılmıştır.

3.14. Araştırmanın Sayıltıları

1. Araştırmadaki tüm katılımcılar ölçme araçlarına dürüst ve içten yanıtlar vermişlerdir.
2. Tüm ölçme araçları deney ve kontrol gruplarına benzer koşullarda uygulanmıştır.
3. Ölçme araçlarıyla ilgili belirtke tablosuna dayalı sorularla desteklenen uzman görüşleri yeterli sayılmıştır.

3.15. Araştırmanın Sınırlılıkları

1. Bu araştırma Hacettepe Üniversitesi Eğitim Fakültesi Fen Bilgisi Eğitimi Anabilim Dalı'ndaki 103 dördüncü sınıf fen bilgisi öğretmen adayıyla ve 2007-2008 Öğretim Yılı Güz Döneminde Özel Öğretim Yöntemleri II dersinin içeriğiyle sınırlıdır.
2. Araştırmacının kişisel özellikleri araştırma açısından yanlılık oluşturabilir. İç geçerliği tehdit edecek olan bu özelliği azaltmak amacıyla deney ve kontrol grubu iki araştırmacı tarafından gözlemlenmiştir.
3. Araştırmada ulaşılabilir örnekleme yoluna başvurulduğu için genelleme problemi oluşabileceğinden aynı çalışma farklı örneklemler üzerinde denenmelidir.
4. Nitel veri analizi araştırmacı haricindeki iki araştırmacının kodlamaları sonucunda elde edilen bilgilerle sınırlıdır ve araştırmacı özellikleri verilerin yorumlanmasını etkileyebilir. Bunu önlemek adına araştırmacılar ortak bir dil kullanmak için çalışmalar yürütmüşlerdir.

3.16. Araştırmanın Geçerliği

Katılımcı özelliklerini sabit tutmak amacıyla deney ve kontrol grubundaki katılımcıların ön test puanları karşılaştırılmış ve sonuçta iki grup arasında anlamlı bir fark bulunmamıştır.

Tarih ve yer tehditleri bu araştırma için kontrol altına alınmıştır. Araştırmada deney ve kontrol gruplarına uygulanan tüm ölçme araçları aynı yer ve zamanda yapılmıştır.

Araştırmada süreç başı ve sonunda veri kaybı olmamıştır. Veri toplama koşulları ve süreci dersin öğretim elemanı tarafından gözlemlenmiş olup yanlılıktan kaçınılmıştır. Uygulayıcı etkisi ise sunuş gözlem formları aracılığıyla kontrol altına alınmıştır.

3.17. Güç Analizi

Araştırmanın gücü örneklem büyüklüğüne bağlı olarak .85 olarak hesaplanmıştır. Araştırmanın yokluk hipotezlerini reddedememe (tip 2 hata yapma) olasılığı .15 tir.

4. Sonuçlar

Araştırmanın sonuçları aşağıdaki gibi özetlenebilir;

1. T-test sonuçlarına göre öğretmen adaylarının önceki başarı puan ortalamaları arasında anlamlı bir fark bulunmamaktadır.
2. Deney ve kontrol gruplarının ön test puanları arasında anlamlı bir fark bulunmamaktadır.
3. Hem betimsel istatistik sonuçları hem de tekrarlayan verilerde varyans analizi sonuçları bilimsel süreç becerileri, fen öğretimine karşı tutum ve ders başarısı değişkenleri açısından deney grubu son test puan ortalamaları kontrol grubu son test puan ortalamalarından istatistiki olarak anlamlı derecede yüksektir. Bu durum deney grubunda yapılan uygulamanın bilimsel süreç becerileri, fen öğretimine karşı tutum ve ders başarısı açısından etkili olduğunu göstermektedir.
4. Deney ve kontrol gruplarının kalıcılık puanları karşılaştırıldığında deney grubunun kalıcılık puanları kontrol grubunun kalıcılık puanlarından istatistiki olarak anlamlı derecede yüksektir.
5. Deney grubu son ve kalıcılık puanları karşılaştırıldığında son ve kalıcılık puanları arasındaki fark az görünse de istatistiki açıdan anlamlı bir düşme görülmüştür.
6. Kontrol grubu son ve kalıcılık puanları karşılaştırıldığında son ve kalıcılık puanları arasındaki fark az görünse de bilimsel süreç becerileri son ve kalıcılık testi

ortalamaları açısından anlamlı bir fark görülmezken fen öğretimine karşı tutum ve ders başarısı değişkenleri açısından kalıcılık puanları yönünden istatistiki anlamda anlamlı bir düşme görülmektedir.

7. Araştırmanın gözlenen etki büyüklüğü ve kestirilen gücü başlangıçta belirlenenden daha yüksek çıkmıştır. Bu da araştırmanın istatistiki anlamlılığını ortaya koymaktır. Araştırmanın pratik anlamlılığını belirlemede son araştırma problemine ait anket ve görüşme analizleri kullanılmıştır.

8. Deney ve kontrol grubu araştırma sürecinin başlangıcında fen eğitimiyle ilgili olarak aynı eksik ve yeterli yönleri vurgularken sürecin sonunda deney grubu süreç başında eksik hissettikleri yanların çoğunu tamamladığını ancak kontrol grubu katılımcıları ise başlangıçta belirledikleri eksik noktaların hiçbirini tamamlayamadıklarını dile getirmişlerdir.

9. Deney grubu katılımcıları süreç sonunda sürece dayalı öğrenci merkezli yöntemleri seçip bununla ilgili gözlenebilir, ölçülebilir nedenler belirtirlerken kontrol grubu katılımcıları daha sınırlı, öğretmen merkezli yöntem ve teknikleri tercih ettiklerini belirtmişler ve bu yöntemleri seçme nedenlerini yeterince açıklayamamışlardır.

10. Deney grubu katılımcıları süreç sonunda alanında başarılı bir fen öğretmenini tanımlarken fen eğitimi ve oluşturmacı yaklaşımının özelliklerini göz önünde bulundururken kontrol grubu katılımcıları sınıfta geleneksel herhangi alanında iyi bir öğretmenin özelliklerini dile getirmişlerdir.

11. Deney grubu katılımcıları başlangıçta belirledikleri beklentilerine ulaştıklarını belirtirken, kontrol grubu katılımcıları çoğu beklentilerine ulaşamadıklarını dile getirmişlerdir.

12. Anket ve odak grup görüşme sonuçları deney grubu katılımcılarının fen eğitimi alanında daha başarılı olduklarını, fen öğretimini etkili bir şekilde gerçekleştirip oluşturmacı yaklaşıma uygun öğrenci merkezli yöntemleri rahatlıkla kullanacaklarına ilişkin pozitif, güçlü algıları vardır. Bu durum da vardamsal istatistik sonuçlarını doğrular niteliktedir.

13. Deney grubunda, süreçte grup çalışmaları, bireysel ve grup değerlendirme formlarının kullanımı onların kendilerini oluşturmacı öğretmenler olarak görmelerini

sağlamış ve öğretme becerilerini geliştirmiştir. Kontrol grubu ise teoride gördükleri olması gerekenlerle sınıf içi ortamda yaşadıkları arasında çelişki yaşamışlar ve süreç sonunda uygulamaya ihtiyaçları olduğunu ifade etmişlerdir.

5. TARTIŞMA

5.1. Sonuçlar ve Tartışma

Araştırma sonucunda elde edilen bulgular literatür bulgularını destekler niteliktedir. Oluşturmacı öğrenme ortamlarında bulunan kişilerin ders başarılarının, tutumlarının ve bilimsel süreç becerilerinin geleneksel öğretim ortamlarında bulunan kişilere oranla daha yüksek olduğu sonucuna ulaşılmıştır (Gatlin, 1998; Hamlin, 2001; Koç, 2002; Thomson ve Soyibo, 2002; Conoly & Beqq, 2006; Akcay, 2007; Savaş, 2006; Yurdakul, 2004; Akar, 2003; Uzuntiryaki, 2003). Kalıcılık puanlarında ise ders başarısı, bilimsel süreç becerileri ve fen öğretimine karşı tutum açısından yine deney grubundaki bireylerin ortalamalarının kontrol grubundaki bireylerin ortalamalarından daha yüksek olduğu sonucuna ulaşılmıştır. Ancak kendi aralarında değerler incelendiğinde deney grubundaki her üç değişken için düşme az olmasına rağmen istatistiki olarak anlamlı bulunmuştur. Kontrol grubunda ise kalıcılık puanlarıyla son test puanları açısından bilimsel süreç becerileri puanlarında anlamlı bir fark bulunmazken diğer puanlardaki düşme az olmasına rağmen istatistiki olarak anlamlı bulunmuştur. Bu sonuç Akar (2003) bulgusuyla zıt yöndedir.

5.2. Öneriler

5.2.1. Uygulamadaki Öneriler

1. Bilimsel süreç becerileri, etkili fen öğretiminin sağlanması için önemli becerilerdir. Bu nedenle oluşturmacı öğrenme ortamları, fen öğretmen eğitimi seviyesinde öğretmen adaylarının bilimsel süreç becerilerini geliştirmek amacıyla kullanılabilir.

2. Fen öğretimine karşı tutum öğrenme öğretme süreçlerinin organizasyonunda büyük rol oynamaktadır. Bu nedenle oluşturmacı öğrenme modeli diğer disiplinlerdeki tutumları da pozitif yönde geliştirmek için kullanılabilir.
3. Oluşturmacı Öğrenme Modeli, bu araştırma kapsamında fen öğretmen adaylarının öğretme becerilerini olumlu yönde etkilediği için diğer öğretim metodoloji derslerinde de kullanılabilir.
4. Deney ve kontrol grubu öğretmen adaylarının davranışları ve öğretme becerileri gerçek sınıf ortamlarında gözlemlenebilir.
5. Hizmet öncesi ve sonrasında oluşturmacı öğrenme modeliyle ilgili çalışmalar yapılıp etkileri gerçek sınıf ortamlarında incelenebilir.
6. Eğitim derslerinde öğrenci merkezli öğretim metodolojileriyle ilgili yaratıcı drama, probleme dayalı öğrenme, proje tabanlı öğrenme konusunda seçmeli dersler açılabilir.
7. Fen öğretmen adaylarına öğrenme süreçleriyle ilgili periyodik geri bildirim verilebilir.
8. Fen öğretmen adaylarının gelişimini farklı boyutlarda gözlemlemek için tamamlayıcı, süreç temelli ölçme ve değerlendirme yaklaşımları kullanılabilir.
9. Sınıf ortamlarının oluşturmacı öğrenme modeline uygun olarak fiziksel özellik ve görünüşleri yeniden düzenlenebilir.
10. Milli Eğitim Bakanlığı ve Yüksek Öğretim Kurulu ile fen eğitimi alanında etkili uygulamalar yapmak üzere işbirliğine gidilebilir.

5.2.2. Diğer Araştırmalar için Öneriler

1. Aynı araştırmanın tekrarı daha geniş örneklem gruplarında genelebilirlik olasılığını yükseltmek için yapılabilir.
2. Gelecekteki araştırmalar fen eğitiminde farklı sınıf seviyelerinde farklı eğitim dersleri kapsamında tekrarlanabilir.
3. Benzer desendeki araştırmalar matematik eğitimi gibi farklı disiplinlerde yapılabilir.

4. Benzer araştırmalar aynı anda öğretmen eğitimi ve ilköğretim düzeyinde gerçekleştirilerek sonuçları karşılaştırılabilir.
5. Bu araştırma yarı deneysel desen ve ulaşılabilir örneklem alınarak gerçekleştirilmiştir. Gelecekteki araştırmalar, tesadüfi örnekleme ile gerçek deneysel desenler tasarlanılarak gerçekleştirilebilir.
6. Bu araştırmada Çok Değişkenli Kovaryans Analizi varsayımları sağlanamadığında daha büyük örneklem gruplarında çalışılarak istatistiki analiz olarak çok değişkenli kovaryans analizi kullanılabilir.
7. Gelecekteki araştırmalar, öğretmen adaylarının motivasyon, öz yeterlik, öğretmen düşünme, karar verme ve planlama değişkenleri kontrol edilerek yapılabilir.
8. Oluşturmacı öğrenme modeli kapsamında boylamsal araştırmalar yapılabilir.
9. Aynı çalışmanın tekrarının daha geniş örneklem gruplarında tekrar edilmesi genellenebilirliğini arttıracaktır.
10. Oluşturmacı öğrenme modeli ve öğrenci merkezli öğretim yöntemlerinin kullanımıyla ilgili program geliştirme çalışmaları yapılabilir.

APPENDIX U

CURRICULUM VITAE

Personal Information

Nationality: Turkish

Date of birth: 29/07/1980

Place of birth: Manisa- Turkiye

Marital Status: Married

Education: 2005- Middle East Technical University Ankara

PhD. in Educational Sciences (Curriculum and Instruction)

Courses taken: Curriculum: Theory and Research, Instruction: Theory and Research, Historical Development of Basic Concepts of Science, Advanced Research Techniques in Education, Comparative Studies of Teacher Education, Practicum Curriculum, Practicum Instruction, Special Topics, PhD Dissertation.

CGPA: 3.75 (out of 4.00)-Taking Performance Award of Middle East Techical University Institute of Social Sciences.

2002-2005 Hacettepe University Ankara

M.S. in Educational Sciences (Measurement and Evaluation Department)

CGPA: 3.38 (out of 4.00)

Courses taken: Curriculum Development and Evaluation-I, Measurement Applications In Computer, Measurement Techniques In Education, Statistical Techniques In Education, Pscyhology of Learning, Curriculum Development and Evaluation-II, Thesis Seminar, Analysis of Variance, Test Development Techniques, Research Techniques, Advanced Statistics In Educational Research and Qualitative Research Techniques In Education (from METU as a special student status)

1998-2002 Hacettepe University Ankara

B.S. Faculty of Education Department of Science Education

CGPA: 3.24 (out of 4.00)

Professional Experience: Hacettepe University, Ankara, Turkey November, 2002

Research assisstant responsible for organization of student programmes, official correspondings, school experience and teaching application organizations and an advisor of 55 students.

Academic Interests: Alternative measurement and evaluation methods in science education, philosophy of science, computer based learning, comparative studies on motivation in the field of mathematics and science, constructivism in science teacher education, evaluation of different countries' curricula, creative drama in education.

Teaching Experience: 2002 Teaching Assisstant Hacettepe University Ankara

Courses Taught

Measurement and Evaluation

Science Laboratuary Applications I and II

Science Laboratuary (for elementary education)

Creative Drama in Education

Introduction to Educational Sciences

School Experience I,II

Practicum in Science Teaching

Science Teaching Methods I, II

Publications

Korkmaz H., Kaptan F., Önal, İ. ve Vaiz, O. "An Investigation About Knowledge and Skills About Technology Use In Pre-service Science Teachers" III. International Educational Technology Conference and Fair May, 28-29-30, 2003, Eastern Mediterranean University Gazimağusa - Turkish Republic of Northern Cyprus

Önal, İ, Kaptan F. "The Reflections of Using Rubrics On Learning and Teaching Process In Science" Sixth National Science and Mathematics Education Congress September, 9-11, 2004, Marmara University Atatürk Education Faculty, İstanbul.

Kaptan F., Önal, İ. "An Investigation About Self Assessment Approach on Preservice Science Teachers in Science Laboratuary Classes" Sixth National Science and Mathematics Education Congress September, 9-11 2004 Marmara University Atatürk Education Faculty, İstanbul.

Kaptan F., Önal İ. "An Investigation About Science process skills for Different Class Levels in Science Education" Structuring Secondary Science Semposium December, 22-24 2004, Başkent Öğretmenevi, Ankara.

Önal, İ. "A Study About Performance Based Assessment In Elementary Science Education" Non published master's thesis from Hacettepe University Department of Educational Sciences Measurement and Evaluation, June, 2005.

Kayhan M., Önal İ. "Investigating Factors That Affect Motivation With Achievement Levels in Preservice Science and Mathematics Teachers. Fourteenth National Educational Sciences Congress. Pamukkale University Faculty of Education September, 28-30, 2005, Denizli.

Önal İ., Kaptan İ. "A Qualitative Investigation About Application of Activity Based Science Education For Developing Science process skills" Fourteenth National Educational Sciences Congress. Pamukkale University Faculty of Education September, 28-30, 2005, Denizli.

Kaptan, F., Önal, İ. (2006) **"**Process Based Measurement and Evaluation Approaches in Science and Technology Education" Contemporary Education Journal, 31-332:9-16

Kaptan, F., Önal, İ. "The Importance of Traditional and Complementary Assessment Approaches in Science and Technology Curriculum." 7th National Science and Mathematics Education Congress, Gazi University Faculty of Education. September 7-8-9, 2006, Ankara.

Önal, İ., Kaptan, F., Kiray, A., Atmaca, S."Constructing an Activity According to Constructivism in Science and Technology Curriculum" Poster Presentation. 7th National Science and Mathematics Education Congress, Gazi University Faculty of Education. September, 7-8-9, 2006, Ankara.

Önal, İ. Kıray, A. "Needs Assessment Study About the Integration of Elementary Science and Mathematics Curricula." XVth National Educational Sciences Congress, Muğla University Faculty of Education, September ,13-14-15, 2006, Muğla.

Önal, İ. "Pre-Service Classroom Teachers' and Instructors' Views about Third Grade Undergraduate Science Teaching Course-The Results of Needs Assessment Study of the Science Teaching Program Evaluation" 1st European Practice-Based and Practitioner Research Conference on Learning and Instruction, Leuven, , October,19-21, 2006, Belgium.

Kaptan, F., Önal, İ., Atmaca, S., Kıray, A.& Aslan, F. "Comparison of the Science and Technology Education Programs- Examples From Different Countries" International Teacher Education Politics and Problems Symposium, Azerbaijan State Pedagogy University, May, 12-14, 2007, Bakı.

Önal, İ.& Kaptan, F. "Practicum Studies of Science and Technology Pre-Service Teachers About New Measurement and Evaluation Approaches and Reflections From the Process" International Teacher Education Politics and Problems Symposium, Azerbaijan State Pedagogy University, May, 12-14, 2007, Bakı.

Kıray, S.A, Önal, İ.& Kaptan, F. "A Study About Pre-Service Teacher's Integration of Science and Mathematics" International Teacher Education Politics and Problems Symposium, Azerbaijan State Pedagogy University, May, 12-14, 2007, Bakı.

Kıray, S.A, Önal, İ. & Demirel, Ö. "An Experimental Investigation of Science and Mathematics Integration in Elementary Level" First National Elementary Congress-Elementary Curricula and Instruction, Hacettepe University, November, 15-17, 2007, Ankara.

Tepe, M., Çalışkan, İ. & Kaptan, F. "Effective Applications in Science Education-Science and Technology Curriculum Eight Grade Cell Division and Heredity Unit" Suzan Erbaş First Science Education Workshop, Onsekiz Mart University, March, 5-7, 2008, Çanakkale.

Oğur, S. Çalışkan, İ.& Kaptan, F. "Effective Applications in Science Education-Science and Technology Curriculum Sixth Grade Light and Voice Unit" Suzan Erbaş First Science Education Workshop, Onsekiz Mart University, March, 5-7, 2008, Çanakkale.

Kınay, E., Koldaş, Z., Çalışkan, İ. & Kaptan, F. "Effective Applications in Science Education-Science and Technology Curriculum Sixth Grade Human and Nature Unit" Suzan Erbaş First Science Education Workshop, Onsekiz Mart University, March, 5-7, 2008, Çanakkale.

Çalışkan, İ, Albayrak, A.& Kaptan, F. "The Views Of Preservice and Inservice Science Teachers' About Complementary Assessment Approaches in Science Education" First National Measurement and Evaluation Congress, Ankara University, 14-16, May, 2008, Ankara.

Languages: English (Well), German (Middle level)

Interests: Creative Drama (Drama leader certificate from Çağdaş Drama Association), ballroom dancing, argentina tango, photography, philosophy, astronomy, classical music, theatre, playing guitar and flute, scuba diving, swimming, winter sports, marbling of papers.

Contact Information

Hacettepe University

Faculty of Education

Department of Science Education
Beytepe, Ankara 06532, Turkey
Phone +90 312 2978625-143
Fax +90 312 2978626

ilkeonal@hacettepe.edu.tr