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Examining the Scientific Creativity of Biology Teacher Candidates According to Their Problem-Solving Skills

Biyoloji Öğretmen Adaylarının Problem Çözme Becerilerine Göre Bilimsel Yaratıcılıklarının İncelenmesi

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Abstract. This study aims to assess the scientific creativity of prospective biology teachers in relation to their problem-solving abilities. The study design is a causal-comparative model, which is one of the standard survey designs. Akdeniz (2014)'s "Scientific Creativity Test" comprised of seven questions used as the data collecting instrument for this study. The research population comprises of second- and fourth-year students in the Biology Education Department of Hacettepe University. The purpose of this study is to compare the scientific creativity levels of second-grade biology teacher candidates who are still adjusting to the teaching profession with those of fourth-grade biology teacher candidates who will become future biology instructors. The accessible sampling technique decided the study's sample size. Consequently, the sample for this study comprises of thirty Hacettepe University Department of Biology Education second- and fourth-grade student volunteers. The research model is a correlational investigation based on the general survey model. In the examination of the study data, the t-test was employed for independent groups and the chi-square approach was utilized for discrete independent variables. According to the findings of the study, there is no statistically significant difference in the levels of scientific creativity of biology teacher candidates based on their problem-solving abilities and gender. There was, however, a substantial difference in the scientific creativity test results of teacher applicants based on grade level. The findings of the study; It may be explained by the fact that second-grade pre-service teachers acquire new knowledge about problem-solving in the teaching process, but fourth-grade pre-service teachers begin to lose this information.
Keywords: *Scientific Creativity, Biology Education, Problem-Solving Skills, Biology Teacher Candidates.*

Öz. Bu araştırmanın amacı, biyoloji öğretmen adaylarının problem çözme becerilerine göre bilimsel yaratıcılık düzeylerinin incelenmesidir. Araştırmanın modeli genel tarama modellerinden nedensel-karşılaştırmalı (causal-comperative) desendir. Araştırmanın veri toplama aracı olarak, Akdeniz (2014) tarafından geliştirilen 7 sorudan oluşan "Bilimsel Yaratıcılık Testi" kullanılmıştır. Araştırmanın evreni Hacettepe Üniversitesi Biyoloji Eğitimi Anabilim Dalı'nda okuyan ikinci sınıf ve son sınıf öğrencilerinden oluşmaktadır. Bunun nedeni olarak, 2. sınıfta öğretmenlik mesleğine yeni alışmaya çalışan biyoloji öğretmen adaylar ile 4. sınıfta okuyan geleceğin biyoloji öğretmeni olacak öğretmen adaylarının bilimsel yaratıcılık düzeylerinin karşılaştırılması amaçlanmaktadır. Araştırmanın örneklemi ulaşılabilir örnekleme yöntemi ile belirlenmiştir. Buna göre araştırmanın örneklemi ise, Hacettepe Üniversitesi Biyoloji Eğitimi Anabilim Dalı'nda 2. ve 4. Sınıflarda öğrenim gören gönüllü 30 katılımcıdan oluşmaktadır. Araştırmanın modeli, genel tarama modelinde ilişkisel bir çalışmadır. Araştırmada elde edilen verilerin analizinde; bağımsız gruplar için t-testi, bağımsız değişkenin kesikli olduğu durumlarda ki-kare yöntemi kullanılmıştır. Araştırmanın sonuçlarına göre; biyoloji öğretmen adaylarının problem çözme becerilerine göre bilimsel yaratıcılık düzeyleri cinsiyet değişkenine göre istatistiksel olarak anlamlı farklılık bulunmamaktadır. Ancak öğretmen adaylarının sınıf düzeyi değişkenine göre bilimsel yaratıcılık testi puanları

arasında anlamlı farklılık saptanmıştır. Araştırmanın sonuçları; 2. sınıf öğretmen adaylarının öğretim sürecinde problem çözmeye yönelik yeni kazandıkları bilgilere hâkim olmaları ve 4. sınıf öğretmen adaylarının öğretim sürecindeki problem çözmeye yönelik bilgileri unutmaya başlamaları ile açıklanabilmektedir.
Anahtar Kelimeler: *Bilimsel Yaratıcılık, Biyoloji Eğitimi, Problem Çözme Becerileri, Biyoloji Öğretmen Adayları.*

Genişletilmiş Özet

Giriş. Biyoloji dersinde öğrenci bilgiyi ezberlemek yerine bilgiye kendi ulaşmalı, deneyler tasarlamalı ve bu deneyler için araştırma yapmalı, hipotez kurarak veri toplamalı, hipotezini test ederek gerektiğinde değiştirip yenilemeli, bir bilim insanı gibi çalışmalı, topladığı bilgileri diğer öğrencilerle paylaşmalıdır (Altunsoy, 2008). Çünkü biyoloji eğitiminin amacı; biyolojiyi seven, dersten zevk alan biyoloji okuryazarı bireyler yetiştirmektir. Biyoloji eğitiminin etkili ve kalıcı olması için öğrenci merkezli öğretme- öğrenme düşüncesine dayandırmış, öğretmenlerin rolü bilgiyi paket şekilde öğrenciye aktarmaktan ziyade öğrenciyi problemle baş başa bırakıp onları problemi çözmeye teşvik ederek koordinasyonu sağlamaktır (Senemoğlu,2000). Ayrıca 21. yüzyıl öğrenmesinde öğrencilerin bilgiye erişim yollarının sınırsız olduğu, işlem becerisi ve hayat boyu öğrenmenin, problem çözme becerisinin, öğretmenin rehber rolünde ve öğrenme kaynaklarının çok çeşitli olduğu, bireyselleştirilmiş, proje odaklı, evrensel öğrenmenin ön plana çıktığı görülmektedir. Buna göre, 21. yüzyılda öğrenenin alıcı olarak görüldüğü, öğretmen merkezli, edilgen, öğrencilerin bilgiyi kitaplardan ve öğretmenden alıp öğrenmesinden ziyade; öğrenenin aktif, grupla çalışabilen, sorgulayan, tartışan, eleştirel bakabilen, proje üreten, bireysel özelliklerine göre öğrenme kaynaklan, materyalleri ve yöntemleri seçebilen, problem çözebilen ve sosyal hayata katılabilen bireyler olarak görüldüğü bir paradigmaya doğru yönelmiştir (Wagner, 2008; Dombrowski & Wagner, 2014; Garda & Temizel, 2016; Fisk, 2017; Fukuyama, 2018). 21. yüzyılda eğitimde paradigmanın değiştiği gerçeğinin kabul edilmesi gerektiğinden yola çıkılarak teknoloji araştırmalarından etkilenen alanlardan biyoloji eğitiminin odak noktasına göre araştırmanın amacı biyoloji öğretmen adaylarının problem çözme becerilerine göre bilimsel yaratıcılık düzeylerinin incelenmesidir. Yapılan araştırmanın geleceğin biyoloji dersinin uygulayıcıları olan biyoloji öğretmen adaylarının biyoloji ile bilimsel yaratıcılık arasında daha objektif bir şeklide gözlem yapmaları açısından görüşlerinin alınmasının ilgili literatüre katkı sağlayacağı düşünülmektedir.

Yöntem. Bu araştırmada, 2. sınıfta öğretmenlik mesleğine yeni alışmaya çalışan biyoloji öğretmen adaylar ile 4. sınıfta okuyan geleceğin biyoloji öğretmeni olacak öğretmen adaylarının bilimsel yaratıcılık düzeylerinin karşılaştırılması amaçlandığından araştırma modeli, genel tarama modellerinden nedensel-karşılaştırmalı (causal-comperative) desen olarak belirlenmiştir. Nedensel-karşılaştırmalı modele göre var olan bir durum veya olayın nedenleri neden-sonuç etki bağlamında incelenmektedir (Büyüköztürk, 2016). Bu araştırma neticesinde, oluşturulan kavramsal modelde yer alan bağımsız ve bağımlı değişkenler arasında neden-sonuç ilişkisini ortaya konulmaktadır. Araştırmanın evrenini, Hacettepe Üniversitesi Biyoloji Eğitimi Anabilim Dalı'nda 2. ve 4. Sınıflarda öğrenim gören öğretmen adaylarından oluşmaktadır. Araştırmanın örneklemi ulaşılabilir örnekleme yöntemi ile belirlenmiştir. Bu bağlamda araştırmanın örneklemi ise, Hacettepe Üniversitesi Biyoloji Eğitimi Anabilim Dalı'nda 2. ve 4. Sınıflarda öğrenim gören gönüllü 30 katılımcıdan oluşmaktadır. Evrenden örneklem alma işleminde Cohen, Manion ve Morrison (2002)'un önerdiği %95 güven düzeyindeki örneklem büyüklüklerine göre 50-60 evrene sahip bir kitleden %95 güven düzeyinde 30-35 arası örneklemin uygun olacağı ve araştırmanın örnekleminin uygun olduğu söylenebilir. Araştırmada, veri tekniği olarak en sık kullanılan yöntem olan anket tekniğinden faydalanılmıştır. Anket 01 Ocak 2020 – 20 Ocak 2020 tarihleri arasında uygulanmıştır. Araştırmanın veri toplama aracı olarak, demografik değişkenlerle (cinsiyet ve sınıf düzeyi) ilgili 2 soru ve Akdeniz (2014) tarafından geliştirilen 7 sorudan oluşan "Bilimsel Yaratıcılık Testi" kullanılmıştır.

Sonuçlar. Biyoloji öğretmen adaylarının bilimsel yaratıcılık testinden aldığı puanlar 59 ile 142 puan arasında değişmektedir. Öğretmen adaylarının aldıkları puanların ortalaması 95,92±21,72 olarak hesaplanmıştır. Öğretmen adaylarının bilimsel yaratıcılıklarının orta düzeyin üzerinde olduğu söylenebilir. Kadın öğretmen adaylarının Bilimsel Yaratıcılık Testi puanları ortalaması 96,77±23,40; erkek öğrencilerin ise 92,20±13,08 olarak bulunmuştur. Öğretmen adaylarının cinsiyetlerine göre Bilimsel Yaratıcılık Testi puanları arasında farklılık bulunamamaktadır ($p>0,05$). Elde edilen bulguya

göre kadın ve erkek öğretmen adaylarının bilimsel yaratıcılıklarının birbirine yakın olduğu söylenebilir. 2.sınıf biyoloji öğretmen adaylarının Bilimsel Yaratıcılık Testi puanları ortalaması 103,94±19,88; 4. sınıf öğretmen adaylarının ise 82,30±18,23 olarak bulunmuştur. Öğretmen adaylarının sınıflarına göre Bilimsel Yaratıcılık Testi puanları arasında anlamlı bir fark saptanmıştır ($p<0,05$). Buna göre 2. sınıf öğretmen adaylarının bilimsel yaratıcılıklarının 4. sınıf öğrencilerinden daha yüksek olduğu söylenebilir.

Tartışma ve Sonuç. Biyoloji eğitimi öğrencilere fiziksel, biyolojik ve teknolojik dünyayı yorumlamak, açıklamak ve geleceği tahmin etmek için temel sağlar. Biyoloji eğitimi ile öğrenciye kazandırılacak olan davranışlar biyolojinin de hedef davranışlarını oluşturmaktadır. Bu bağlamdan yola çıkarak araştırmada 2. Sınıf ve 4. Sınıfta öğrenim gören biyoloji öğretmen adaylarının bilimsel yaratıcılık düzeyleri Bilimsel Yaratıcılık Testi kullanılarak belirlenmiştir. Bilimsel Yaratıcılık Testi ile öğretmen adaylarının problem bulma, çözüm önerme, hipotez geliştirme ve hipotez test etme becerileri ölçülmeye çalışılmıştır. Sorular akıcılık, esneklik ve orijinallik alt boyutlarına göre değerlendirilmiş ve öğretmen adaylarının verdikleri cevaplar incelenmiştir.

Araştırma sonucunda; öğretmen adaylarının bilimsel yaratıcılık puan ortalaması 95,92±21,72 olarak hesaplanmıştır. Alınan en yüksek puan 142, en düşük puan ise 59'dur. Öğrencilerin bilimsel yaratıcılık düzeylerinin orta düzeyin üzerinde olduğu söylenebilir. Türkiye'de bilimsel yaratıcılıkla ilgili yapılan diğer araştırmalarda da öğrencilerin bilimsel yaratıcılıklarının düşük ya da orta düzeyde olduğu görülmektedir (Kadayıfçı, 2008; Kılıç, 2011; Akkanat, 2012). Bu da araştırmanın bulgularını destekler niteliktedir. Kadayıfçı (2008) yaratıcı düşünmeyi destekleyen bir öğretim modelinin, 9. sınıf kimya öğrencilerinin maddelerin ayrılması konusuyla ilgili kavramalarına, imajlarına, ıraksak düşüncelerine ve bilimsel yaratıcılıklarına etkisini geleneksel öğretim yaklaşımıyla karşılaştırarak incelediği çalışmasında uyguladığı bilimsel yaratıcılık testi sonuçlarının genel ortalama puanlarının 60–70 puan aralığında olduğu görülmektedir. Kılıç (2011) İlköğretim sekizinci sınıf öğrencilerinin bilimsel yaratıcılık ve bilimsel tutum düzeylerini belirlemek amacıyla yaptığı çalışmasında öğrencilerin bilimsel yaratıcılık testi puanlarının ortalamasının 62,300 olduğu görülmektedir. Akkanat (2012) İlköğretim 7. sınıf öğrencilerinin bilimsel yaratıcılık düzeylerini incelemek amacıyla yaptığı çalışmasında öğrencilerin bilimsel yaratıcılık testi puanlarının ortalamasının 72,900 olduğu görülmektedir. Akdeniz (2014)'ün ortaöğretim biyoloji dersi ile öğrencilerin bilimsel yaratıcılıkları arasındaki ilişkinin incelediği araştırmada öğrencilerin bilimsel yaratıcılık testi puanlarının ortalamasının 56,884 olduğu görülmektedir. Bu sonuçlar araştırmanın bulgularını desteklemektedir. Bu araştırma sonuçları da literatürde yer alan araştırma sonuçlarıyla benzerlik göstermektedir.

Biyoloji öğretmen adaylarının cinsiyet değişkenine göre bilimsel yaratıcılık testi puanları arasında farklılık bulunamamaktadır ($p>0,05$). Buna göre öğrencilerin bilimsel yaratıcılıklarında cinsiyet faktörü etkili olmadığı söylenebilir. Alan yazında bu bulguyu destekleyen farklı örneklemlerle yapılmış araştırmalar bulunmaktadır (Majumdar, 1975; Sansanwal ve Sharma 1993; Hu & Adey, 2002; Mohamed, 2006; Ayverdi vd., 2012; Akdeniz, 2014) Alan yazında bu bulguyu desteklemeyen çalışmalar da yer almaktadır (Aslan, 1994; Kılıç, 2011). Bu sonuçlar, kız öğrencilerin erkek öğrencilere göre, bilimsel yaratıcılık düzeylerinin daha yüksek olduğunu göstermektedir. Bu farklılık araştırmaların niteliklerine bağlı olarak (katılımcı grubu, veri toplama araçları vb. gibi) ortaya çıkmış bir sonuç olarak değerlendirilebilir.

Biyoloji öğretmen adaylarının sınıf düzeyi değişkenine göre bilimsel yaratıcılık testi puanları arasında anlamlı bir fark saptanmıştır ($p<0,05$). Bu durum 2. sınıf öğretmen adaylarının öğretim sürecinde problem çözmeye yönelik yeni kazandıkları bilgilere hâkim olmaları ve 4. sınıf öğretmen adaylarının öğretim sürecindeki problem çözmeye yönelik bilgileri unutmaya başlamaları ile açıklanabilir. Çünkü öğretmen adayları üst sınıf düzeyine geçtikçe biyoloji eğitiminin felsefesinin temellerinde derinleşme, genelleme ve değişik yaklaşımlarda bulunabilme imkânı bulacaklardır. Bu kapsamda 4.sınıf öğretmen adaylarının bilimsel yaratıcılık testi puanları ortalamasının yüksek olmasının nedeni biyolojik okuryazar ve biyoloji kültür seviyelerinin ve diğer sınıf düzeylerine göre daha yüksek olmasından dolayı olduğu söylenebilir. İlgili literatürde Akdeniz (2014) tarafından yapılan araştırmada Sınıf düzeylerine göre öğrencilerin bilimsel yaratıcılık puanları karşılaştırıldığında 12. sınıf

öğrencilerinin bilimsel yaratıcılık puanlarının 9., 10. ve 11.sınıf öğrencilerinden yüksek olduğu ve bunun istatistiksel olarak anlamlı olmadığı sonucuna ulaşılmıştır. Bu sonuç araştırmanın bulgularını desteklemektedir.

Introduction

Information and technology are constantly changing, renewing, and rising as the movement grows and develops as a result of globalization. Societies trying to keep up with this change are trying to teach their young people how to access information. The purpose of information societies is to raise generations who are aware of the problem, research, examine, question, and produce solutions to problems (Tatar, 2006).

In order to achieve this, the curriculum aims to train individuals who research, think critically, solve problems, have effective communication skills, cooperate, question, interpret, share, think reflectively, produce, have scientific skills, and are lifelong science enthusiasts (MEB, 2018).

The demand is migrating away from regular, traditional work and toward more sophisticated, nonroutine jobs as a consequence of increased globalization and technological advancement. This movement in demand may be attributed to the following: (Autor, Levy, & Murnane, 2003). Creativity in its broadest sense and scientific creativity in its more specific definition are both essential abilities for designing the future in a way that is inventive, sustainable, and resource-effective. Both Sternberg (2010) and Ghassib (2010) argue that scientific knowledge, creativity, and sagacity are necessary components in the development of civilizations. Children and teenagers need to be prepared for and given training in higher order thinking abilities like creative and critical thinking as part of their formal education (Pacheco & Herrera, 2021). They have to be able to manage new challenges for which they do not have a plan and think creatively and flexibly about how to go around roadblocks on the way to a solution. Additionally, they have to be able to deal with challenges for which they do not have a strategy. They need to acquire the skills necessary to cope with unanticipated circumstances (Kind & Kind, 2007; Marope, Griffin, & Gallagher, 2017; OECD, 2014).

Hu and Adey (2002, p. 391) defined scientific creativity as "a kind of intellectual trait or ability that produces a certain product that is original and has social or personal value." In the year 2002, Hu and Adey developed what is now known as the Scientific Structure Creativity Model. Both the Guilford Model of the Structure of Intelligence (Guilford, 1956, 1967, and 1968) and the Torrance Test of Creative Thinking served as its foundations (Torrance, 1966; 2008). Their model is composed of three components: the scientific procedure, the conclusion of the scientific investigation, and a personality characteristic. To succeed in the process dimension, you will need to use scientific reasoning with your creative side. The four components that make up the scientific product dimension are the scientific issue, the scientific phenomena, the scientific knowledge, and the technological product. The personality characteristic dimension, as described by Guilford, encompasses traits such as fluency, adaptability, and inventiveness (Guilford, 1956, 1967, 1968). In 2002, Hu and Adey developed what is now known as the Scientific Creativity Test. It was based on the model that they provided (SCT). It consists of seven components, each of which is a measurement of a distinct aspect of the Scientific Structure Creativity Model. The SCT is a test that is supposed to be delivered in groups and is designed for high school students to take using paper and pencil. Two of these questions are quite similar to the "Just assume" and "Unusual Uses" tasks on the Torrance exam; however, they are centered on scientific concepts. Another one of your skills will be evaluated based on how well you can generate scientific inquiries. Two of the questions include the solution of scientific issues and the observation of scientific phenomena. The other four questions concern technological goods and ask how these items might be improved or how they can be constructed. In spite of the fact that the SCT has been used in a multitude of investigations (Demirhan and Sahin, 2019; Hu et al., 2013; Lin et al., 2003; Sun, Wang, and Wegerif, 2020; Yang, Lee, Hong, and Lin, 2016), it is essential to keep in mind that it has a few drawbacks. Comparisons of students of different ages and face validity from a group of 35 educators and scientists that specialize

in the study of scientific education were the two primary methods that were used to determine the validity (Runco, 2010). Additionally, it is unclear if the multifaceted concept of scientific creativity can really be measured by a single test at all, given that it includes a variety of distinct brain processes (Pacheco & Herrera, 2021; Sak & Ayas, 2013).

With these advancements in science and technology, it is more important than ever to choose the correct knowledge and use it at the proper time and place. We must accelerate scientific progress if we are to profit from the results of research and technology (Temizyürek, 2009). Science's relevance in achieving this goal cannot be underestimated. As a result, science education, which aims to educate scientifically literate individuals who can recognize a problem, obtain information about a solution, produce several alternatives, and accept responsibility for their judgments, is critical (MEB, 2018). Students' interests and research skills are developed through science education. According to Kaptan and Kuşakçı (2004), science education should aim to make individuals who are creative, exploratory, able to access information, productive, have scientific and rational thinking skills, and can communicate information rather than memorize it. As a result of the changing economic activities and the advancement of technology in the education and training process, differentiation of individual and societal expectations, evaluation of national and worldwide tests, and the development and change of teaching programs are all necessary (MEB, 2017). In the designed and changed curriculums, there are behaviors that are wanted to be learned by the individual during the education and training process. In the education process, behaviors such as adapting to the age, researching, questioning, problem-solving, critical thinking skills, analytical thinking skills, constructing one's own knowledge, accepting the changeability of knowledge, and revealing new knowledge by analyzing existing knowledge are the behaviors that are desired to be gained through the curriculum (MEB, 2017). A set of skills that can be taught have been developed so that students can easily adapt to the 21st century conditions (Marzano & Heflebower, 2011). These skills expected from students have also taken their place in education programs. The Ministry of National Education states that the purpose of the curriculum regulations is to train students who are suitable for the needs of the age and the skills they need (MEB, 2018). The purpose of the 21st century education program; It is to raise individuals who can produce information, use the information learned in daily life, look at events from multiple perspectives, think critically, and have effective communication skills. Therefore, MNE revised 51 areas in the education program, taking into account 21st century skills, and outlined the learner abilities and skills required by the 21st century (MEB, 2018).

In Turkey, especially in recent years, curriculum revisions have been implemented to match the needs of the age group. With the revisions, it is aimed to break the mold by bringing learning that combines many disciplines rather than the boring, teacher-centered learning that currently dominates our educational system, allowing students to reach information through their own learning. With the recent curriculum revision, the Ministry of National Education has switched from a behaviorist to a constructivist approach. According to the constructivist approach, the individual does not get information directly from the teacher, but rather constructs and realizes his/her own knowledge via his/her own learning. In the context of this understanding, the Science and Technology curriculum was rearranged in 2004 and it started to be implemented in all schools throughout Turkey in the 2005-2006 academic year (Çınar, Teyfur, & Teyfur, 2006).

The changes made in the Science and Technology lesson program in 2004 were deemed necessary in the Biology lesson curriculum along with other science fields, and these programs were changed by the Ministry of National Education in 2008 (Horasan, 2012). Changes to the Science and Technology lesson program in 2004 were judged required in the Biology lesson curriculum, as well as other science subjects, and the Ministry of National Education revised these programs in 2008. (Horasan, 2012). As a result, biology lessons began to be taught in schools with a constructivist approach to the curriculum. Since it is vital to seek solutions from other viewpoints and to use

knowledge from other fields to solve problems in biology education when there are challenges in solving current problems and there is a lack of available information. Today, the problem can be solved by learning 21st-century skills (problem-solving, entrepreneurship, creativity, critical thinking, flexible thinking, etc.) (Bahar et al., 2018). Science education has a great significance in raising individuals with the desired characteristics and therefore science education should be organized effectively (Yıldırım & Selvi, 2017). The importance of biology education and the need for education in this field are increasing since biology, which is a branch of science, affects human life with the relationships between nature, environment, plants, microorganisms, animals, and sustainable resources.

In terms of the disciplines, it contains, biology is directly or indirectly related to many other branches (Çilenti and Özçelik, 1991). Biology courses cover different science fields, such as chemistry and physics, as well as some subjects and mathematics. However, biology is a part of science that allows the use of technology in the context of 21st-century skills. In order for each individual to get the successes of the disciplines that are related to each other, it is vital to integrate the fields with the curricula.

Science is divided into three branches in secondary education as physics, chemistry and biology. Biology, one of these branches and described as the science of the 21st century, aims to provide solutions to problems by observing the world and using scientific steps like other sciences. With biology education, methods are taught that will enable students to gain scientific thinking skills and to solve the problems they encounter throughout their lives with positive attitudes and approaches (Ministry of National Education [MEB], 2018).

In Turkey, a rote-based approach to science teaching is used, particularly in biology. In general, biology education takes the form of a process in which the teacher is at the center and the students memorize concepts, laws, theories, and hypotheses primarily in Latin while following the textbook's instructions. As a result, students are unable to make a relationship between the biology lesson and the world, to transfer the information they have learned to everyday life, to forget the information in a short period of time because they are unable to save the information in their long-term memories, and to develop scientific process skills (Altunsoy, 2008). It is not possible for students to understand science, realize the significance of science, and learn to think scientifically, for a biology course that is devoid of laboratories limited to the textbook and classroom environment and taught by the teacher.

Instead of memorizing information, the student should seek it out for oneself, design experiments and conduct research for them, collect data by forming hypotheses, test his/her hypothesis and revise it as needed, work like a scientist, and share the information he/she collects with other students (Altunsoy, 2008). The purpose of biology education is to teach biology literate individuals who enjoy learning about biology. To be effective and long-lasting, biology education must be based on the student-centered teaching-learning concept, with teachers' roles being to provide coordination by leaving students alone with problems and encouraging them to solve them rather than transferring information to them in a package (Senemoğlu, 2000). This is possible by arranging biology education programs in a way that will improve students' problem solving, analysis, synthesis, criticism and interpretation skills, as well as their interest and ability in fine arts such as music, painting, and literature. In fact, since the brain has a holistic structure whose functions complement each other, and the development of creativity depends on a balanced stimulation of the brain, taking this holism into account (Kale, 1994). The arrangements made for the development of creativity should primarily reflect the aims of the education programs. Educational programs that prefer to use and produce information instead of loading and storing information will be more effective in the development of creativity (Atkıncı, 2001).

According to Summak and Aydın (2011), science education is useful in enhancing people's creativity and presenting them with different perspectives. Biology is the branch of study with the most direct or indirect connections to other branches of research (Çilenti and Özçelik, 1991). The biology course covers topics that are covered in other science courses, including chemistry and physics. As a result, creativity in science is comparable to creativity in biology. Since biology makes people aware of nature's ability to solve problems and come up with solutions. The formation of that light in the minds of scientists is influenced by biology. Furthermore, according to Newton and Newton (2009), teachers should be well informed about the concept of creativity.

In 21st century learning, it is seen that students' access to information is unlimited, process skills and lifelong learning, problem solving skills, teacher's guide role and learning resources are diverse, individualized, project-oriented, universal learning comes to the fore. Accordingly, in the 21st century, the learner is seen as a receptive, teacher-centered, passive, rather than learning the information from the books and the teacher; It has tended towards a paradigm in which learners are seen as active, able to work in groups, questioning, discussing, critical, producing projects, choosing learning resources, materials and methods according to their individual characteristics, solving problems and participating in social life (Dombrowski & Wagner, 2014; Garda & Temizel, 2016; Fisk, 2017; Fukuyama, 2018). Based on the fact that the paradigm has changed in education in the 21st century, the aim of the research is to examine the scientific creativity levels of biology teacher candidates according to their problem solving skills, according to the focus of biology education, which is one of the areas affected by technology research. It is thought that taking the opinions of biology teacher candidates, who are the practitioners of the future biology course, in terms of making observations between biology and scientific creativity in a more objective way will contribute to the relevant literature. As a result of the relevant literature research, no study examining the relationship between the field of biology and scientific creativity was found among the studies conducted in the field of creativity and scientific creativity, which is a type of creativity. It is considered that taking the opinions of biology teacher candidates, who are the practitioners of the future biology course, in terms of making observations between biology and scientific creativity in a more objective way will contribute to the relevant literature.

Method

Research Design

The research model for this study was determined as the causal-comparative design, one of the general survey models because it was aimed to compare the scientific creativity levels of biology teacher candidates who are just getting used to the teaching profession in the 2nd grade and prospective biology teachers who will be in the 4th grade. The causes of a current situation or event are analyzed in the framework of cause and effect, according to the causal-comparative model (Büyüköztürk, 2016).

As a result of this research, each path indicated by one-way arrows between independent and dependent variables in the conceptual models created reveals a cause-effect relationship. According to Karasar (2016), while stating that the information obtained with the survey model cannot be accepted as a real cause-effect relationship, Karasar also stated that the relationships found by survey design can be interpreted as a cause-effect relationship due to the economic, technical, or ethical difficulties encountered in conducting the research.

Population and Sample of the Research

Teacher candidates in Hacettepe University's Department of Biology Education studying in the 2nd and 4th grades make up the study's universe. The study's sample was determined by the most accessible sampling method. In this context, the research sample consisted of 30 participants from Hacettepe University's Department of Biology Education in the 2nd and 4th grades. According to Cohen, Manion, and Morrison (2002)'s sample sizes at the 95% confidence level in the sampling process from the population, a sample of 30-35 from a population of 50-60 would be appropriate at the 95% confidence level, thus the study's sample was appropriate.

The findings regarding the distribution of demographic information of the participants included in the study are given in Table 1.

Table 1.
Distribution of Demographic Information of Participants

		Frequency (f)	Percentage (%)
Gender	Woman	24	%80
	Man	6	%20
Grade Level	2. Grade	20	%66,7
	4. Grade	10	%33,3
Total		30	%100,0

According to Table 1, 80% of the participants are female and 20% are male. 66.7% of the students are in the 2nd grade, 33.3% of them are in the 4th grade.

Research Instruments and Procedures

Questionnaire technique, which is the most frequently used method as a data technique, was used in the research. The survey was applied between 01 January 2020 – 20 January 2020.

Demographic information form. Within the scope of the purpose of the research, there are 2 questions about demographic variables (gender and class level).

Scientific creativity test. "Scientific Creativity Test" consisting of 7 questions developed by Akdeniz (2014) was used. The questions in the test consist of open-ended questions that measure students' ability to find problems, generate hypotheses, test hypotheses and propose solutions, which are thought to be related to scientific creativity. Therefore, since it measures creativity, there are no exact correct answers. A scientific creativity score is obtained at the end of the answer evaluation. For each question, fluency, flexibility, and originality scores are also calculated.

Validity and reliability of the scientific creativity test. The Cronbach α internal consistency coefficient of the test was calculated as 0.752. As a result of the item analysis, the reliability of the scale items was calculated by using total item correlations. An item with total item correlation coefficients $r \geq 0.40$ is a very good item, and an item with $0.30 \leq r \leq 0.39$ is a good item (Büyüköztürk, 2010).

Data Analysis

The sum of the fluency, flexibility, and originality scores in the scientific creativity test is used to assess the first, second, third, fourth, and seventh questions. The number of valid answers given to the questions determines the fluency score. The flexibility score is calculated by assigning one point to each suggested group or class based on the responses to the questions. The rarity of the answers in the sample is used to determine the originality score. The number of responses produced for each problem, as well as the number of conceptual categories in the answers, are taken into account when calculating the fluency score. Then, it was determined how many times each answer was repeated in the pool where the answers were collected. This situation was used to determine the originality score of the students. Each answer that is found between 5% and 10% of all answers to each question is given 2 points, and answers that are less than 5% are given 3 points. In the 5th and 6th questions, 1 point was given for each number of methods, and points were given for the scientificalness of the method according to the rubric. 2 points were given for full scientific methods and explanations, 1 point for partial scientific explanations, and methods, and 0 points for non-scientific explanations and methods.

The normality distribution of the Scientific Creativity test scores is given in Table 2.

Table 2.
Scientific Creativity Test Normality Test Results

Scientific Creativity Test			Shapiro-Wilk
	Statistic	**SD**	**p**
	0,950	27	0,219

According to Table 2., it can be said that the scale is suitable for the normality distribution (p>0.05). For this reason, parametric tests were used to analyze the data.

Results

The values of the "Scientific Creativity Test" scores of the biology teacher candidates (arithmetic mean, standard deviation, standard error, minimum and maximum values) are given in Table 3.

Table 3.
Distribution of Biology Teacher Candidates' Scientific Creativity Test Scores

Questions	**Smallest Score**	**Highest Score**	**Range of Change**	**$\bar{x}$**	**Standard Error**	**Standard Deviation**
Problem Notice	6	70	64	37,83	2,85	15,65
Writing A Feature	5	27	22	16,06	0,96	5,26
Reason Sorting	3	17	14	10,79	0,69	3,73
Finding Solutions	10	21	11	13,85	0,56	3,00
Possible Explanations	5	30	25	14,00	0,94	5,06
Acid Rain	0	4	4	2,71	0,23	1,24
Farmers And Their Products	2	6	4	3,17	0,21	1,13
Total	59	142	83	95,92	4,18	21,72

According to Table 3., the scores of biology teacher candidates from the scientific creativity test range from 59 to 142 points. The mean scores of the pre-service teachers were calculated as

95.92±21.72. It can be claimed that the scientific creativity of the teacher candidates is above the medium level.

The findings regarding the Scientific Creativity Test scores of biology teacher candidates according to their gender are presented in Table 4.

Table 4.
Independent Samples t-Test Results Regarding the Scientific Creativity Test Scores of Biology Teacher Candidates by Gender Variable

	Gender	x̄	Standard Error	Standard Deviation	t	p
Scientific Creativity Test	Female	96,77	4,98	23,40	0,418	0,679
	Male	92,20	5,85	13,08		

p<0,05

According to Table 4., the mean Scientific Creativity Test scores of female teacher candidates were found to be 96.77±23.40, and 92.20±13.08 for male students. There was no difference between the Scientific Creativity Test scores of teacher candidates according to their gender (p>0.05). According to the findings, it can be stated that the scientific creativity of female and male teacher candidates is close to each other.

The findings regarding the Scientific Creativity Test scores of the biology teacher candidates according to their grade levels are given in Table 5.

Table 5.
Independent Samples t-Test Results of Biology Teacher Candidates' Scientific Creativity Test Scores According to Grade Level Variable

	Grade Level	x̄	Standard Error	Standard Deviation	t	p
Scientific Creativity Test	2. Grade	103,94	4,82	19,88	2,812	0,009*
	4. Grade	82,30	5,76	18,23		

p<0,05

According to Table 5., the average of the Scientific Creativity Test scores of the 2nd grade biology teacher candidates was found to be 103.94±19.88, and the 4th grade teacher candidates were found to be 82.30±18.23. A significant difference was found between the Scientific Creativity Test scores of the teacher candidates according to their classes (p<0.05). Accordingly, it can be said that the scientific creativity of the 2nd-grade teacher candidates is higher than that of the 4th-grade students.

Discussion, Conclusion and Suggestions

Biology education provides the basis for students to interpret, explain, and predict the physical, biological, and technological world. Observation, hypothesis, testing, collecting information, interpreting data, and sharing results are all skills in biology. It also aids in the development of creative thinking in students. In this sense, biology is the scientific discipline that is closest to the center (Çilenti & Özçelik, 1991). The target behaviors of biology are the behaviors that students will acquire as a result of their biology education. The Scientific Creativity Test was used to measure the

scientific creativity levels of biology teacher candidates in the 2nd and 4th grades based on this context. With the Scientific Creativity Test, it was tried to measure the teacher candidates' ability to find problems, propose solutions, develop hypotheses, and test hypotheses. The questions were evaluated according to the sub-dimensions of fluency, flexibility, and originality, and the answers given by the pre-service teachers were examined.

As a result of the research, the scientific creativity score average of the teacher candidates was calculated as 95.92±21.72. The highest score obtained is 142 and the lowest score is 59. It can be said that the scientific creativity levels of the students are above the medium level. In other studies on scientific creativity in Turkey, it is seen that students' scientific creativity is at a low or moderate level (Kadayıfçı, 2008; Kılıç, 2011; Akkanat, 2012). This supports the findings of the research. By comparing the effect of a teaching model that supports creative thinking on 9th-grade chemistry students' understanding, images, divergent thoughts, and scientific creativity with the traditional teaching approach, Kadayıfçı (2008) found that the general average scores of the scientific creativity test results he applied were in the range of 60-70 points. Kılıç (2011) conducted a study to determine the scientific creativity and scientific attitude levels of 8th-grade primary school students, and it was seen that the average of the students' scientific creativity test scores was 62,300. Akkanat (2012), in the study to examine the scientific creativity levels of primary school 7th-grade students, found that the average of the students' scientific creativity test scores was 72,900. In the study of Akdeniz (2014) in which the relationship between the secondary school biology course and the scientific creativity of the students was examined, it was observed that the average of the students' scientific creativity test scores was 56,884. These results support the findings of the study. The results of this research are also similar to the results of the research in the literature.

There is no difference between the scientific creativity test scores of biology teacher candidates according to the gender variable. Accordingly, it can be claimed that the gender factor is not effective in the scientific creativity of the students. In the literature, there are studies with different samples supporting this finding (Majumdar, 1975; Sansanwal & Sharma 1993; Hu & Adey, 2002; Mohamed, 2006; Ayverdi et al., 2012; Akdeniz, 2014; Aslan, 1994; Kılıç, 2011). These results show that female students have higher scientific creativity levels than male students. This difference can be viewed as a result that has evolved as a result of the research's characteristics (participant group, data collection tools, etc.).

According to the grade level variable, there was a significant difference in the scientific creativity test scores of the biology teacher candidates ($p<0.05$). This situation can be explained by the fact that pre-service teachers in the second grade have just obtained knowledge about problem-solving in the teaching process, whereas pre-service teachers in the 4th grade begin to forget that knowledge. Since, as pre-service teachers progress through the grades, they will have the opportunity to deepen, generalize, and apply multiple approaches to the foundations of biology teaching philosophy. In this context, the high average of 4th grade teacher candidates' scientific creativity test results can be attributed to their greater biological literacy and biology culture levels when compared to other grade levels. When the scientific creativity scores of students were compared according to their grade levels in the study conducted by Akdeniz (2014) in the related literature, it was concluded that the scientific creativity scores of the 12th grade students were higher than the 9th, 10th, and 11th grade students, but this was not statistically significant. This result supports the study's findings.

In the light of the results obtained, different suggestions were made to researchers and practitioners:

- It is advised to develop awareness activities by determining the level of scientific creativity as a state education policy, to increase the awareness of teacher candidates studying in

education faculties and Ministry of National Education (MNE) teachers about scientific creativity and problem-solving skills, and to provide necessary qualifications for teachers through various education.

- Focus group studies and action researches can be carried out within the scope of the activities to be developed so that teacher candidates can more associate their scientific creativity levels with the biology lesson. In this context, precautions may have been taken for the negative effects and disadvantages that can emerge in associating scientific information with their daily lives.
- Mixed method can be applied by using quantitative and qualitative studies to research with different study groups and sampling methods. Thus, the research results will be more generalizable and the research problem situation can be analyzed in deps

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