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Evaluation of the 12th Grade Biology Curriculum with the Opinions of Biology Teachers

Biyoloji Öğretmenlerinin Görüşleriyle 12. Sınıf Biyoloji Öğretim Programının Değerlendirilmesi

Hulya PEHLIVAN, Instr.Dr., Hacettepe University, hulyapeh@hacettepe.edu.tr

Gamze MERCAN, Dr., gmercn@gmail.com

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Abstract. The aim of this research is to examine the extent to which the current 12th-grade biology curriculum is effective in developing students' skills such as being research-oriented and inquisitive, critical thinking, decision-making, problem-solving, lifelong learning, self-awareness, and understanding of oneself and the environment. Additionally, the study aims to investigate the adequacy of the curriculum in developing students' knowledge, skills, attitudes, values, and understanding related to biology, as perceived by 12th-grade biology teachers. The research design employed in this study is a case study, which is a qualitative research method. The study group was determined through purposive sampling, specifically using a type of purposive sampling called criterion sampling. The participants in the study group were biology teachers who have previously taught the 12th-grade biology curriculum that was previously implemented and is currently being implemented. Accordingly, the study group consists of 72 biology teachers. The data collection instrument used in the research includes a demographic questionnaire (gender, professional seniority) consisting of 2 questions and an interview form consisting of 11 semi-structured open-ended questions to determine the participants' opinions about the 12th-grade biology curriculum. The findings of the research were analyzed using the content analysis technique with the assistance of MAXQDA 2022 software. According to the results of the research, it can be stated that the current 12th-grade biology curriculum received mostly positive feedback from the majority of biology teachers in terms of learning outcomes, instructional activities, and content.
Keywords: Biology Education, 12th Grade Biology Curriculum, Biology Teachers, Biology Lesson, Case Study.

Öz. Bu araştırmanın amacı güncel 12. Sınıf biyoloji öğretim programının öğrencilere kazandırmayı hedeflediği araştırmacı-sorgulayıcı olma, eleştirel düşünme, karar verme becerisine sahip olma, problem çözebilme, yaşam boyu öğrenme gibi özelliklere sahip olma, kendisini ve çevresini tanıma ve anlama gibi özellikleri kazandırmada ne derece yeterli olduğunun yanı sıra öğrenenlerin biyoloji ile ilgili, bilgi, beceri, tutum, değer ile anlayışları kazandırmada ne derecede yeterli olduğunu 12. Sınıf biyoloji öğretmenlerinin görüşleriyle incelenmesidir. Araştırmanın modeli olarak nitel araştırma yöntemlerinden durum çalışması (case study) deseni kullanılmıştır. Araştırmanın çalışma grubu, amaçlı örnekleme yöntemlerinden benzeşik örnekleme ile belirlenmiştir. Araştırmanın çalışma grubunu oluşturan katılımcıların ortak özelliği daha önce uygulanmakta olan ve şuan uygulanan 12. sınıf biyoloji öğretim programı dersini vermiş biyoloji öğretmenleri olmalarıdır. Buna göre araştırmanın çalışma grubu 72 biyoloji öğretmeninden oluşmaktadır. Araştırmanın veri toplama aracı olarak katılımcıların demografik özelliklerini (cinsiyet, mesleki kıdem) 2 soru ve 12. Sınıf biyoloji öğretim programı hakkındaki görüşlerinin belirlenmesine yönelik 11 yarı yapılandırılmış açık uçlu sorudan oluşan görüşme formu kullanılmıştır. Araştırmadan elde edilen bulgular MAXQDA 2022 Programı kullanılarak içerik analiz tekniği ile analiz edilmiştir. Araştırmanın sonuçlarına göre; güncel 12. Sınıf biyoloji öğretimi programı biyoloji öğretmenlerinin çoğunluğu tarafından kazanım, öğretim etkinlikleri, ders içeriği açısından olumlu görüş bildirildiği söylenebilir.
Anahtar Kelimeler: Biyoloji Eğitimi, 12.Sınıf Biyoloji Öğretimi Programı, Biyoloji Öğretmenleri, Biyoloji Dersi, Durum Çalışması.

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Genişletilmiş Özet

Giriş. Bu araştırma, güncel 12. Sınıf biyoloji öğretim programının öğrencilere araştırmacı-sorgulayıcı olma, eleştirel düşünme, karar verme, problem çözme ve yaşam boyu öğrenme gibi beceriler kazandırmada ne derece etkili olduğunu incelemeyi amaçlamaktadır. Özellikle, öğrencilerin biyoloji alanında bilgi, beceri, tutum, değer ve anlayış kazanımı üzerine odaklanılmaktadır. Bu çerçevede, 12. Sınıf biyoloji öğretmenlerinin görüşleri, programın öğrencileri kendilerini ve çevrelerini tanıma ve anlamada ne kadar desteklediğini belirlemek için değerlendirilmiştir. Bu çalışma, eğitim programlarının etkinliğini ölçmek ve gelecekteki iyileştirmeler için temel oluşturmak amacıyla önem taşımaktadır.

Yöntem. Araştırmada biyoloji dersinin aktörleri olarak biyoloji öğretmenlerinin 12. Sınıf biyoloji öğretim programı hakkındaki görüşlerinin incelenmesi amacına yönelik olarak nitel araştırma yöntemlerinden durum çalışması (case study) deseni kullanılmıştır. Eğitim alanında yapılan çalışmalarda çok fazla kullanılan araştırma yöntemlerinden biri olan durum çalışmaları, bilimsel sorulara cevap aramada kullanılan ayırt edici bir yaklaşım olarak görülmektedir. Araştırmanın amacı kapsamında biyoloji öğretmenlerinin 12. Sınıf biyoloji öğretim programı hakkındaki görüşleri aynı araştırma sorularıyla tek durum çalışması deseni kullanılmıştır. Tek durum çalışmaları tek bir durumu inceleyerek o durumu ve yer alan unsurları anlamaya yönelik çalışmalardır (Ersoy, 2016). Araştırmanın çalışma grubu, amaçlı örnekleme yöntemlerinden benzeşik örnekleme ile belirlenmiştir. Benzeşik örneklemede birbirine benzer birey, grup, olay veya kurumların detaylı bir şekilde incelenmek istendiği durumlarda kullanılır ve genellikle benzer bireyleri içeren bir alt grubun oluşturulması tercih edilir (Patton, 2002). Bir diğer deyişle örnekleme seçilen katılımcıların ortak özelliği bulunmakta ve bu özelliğe sahip olmayan katılımcılar örnekleme dahil edilmemektedir (Yıldırım ve Şimşek, 2018). Araştırmanın çalışma grubunu oluşturan katılımcıların ortak özelliği daha önce uygulanmakta olan ve şuan uygulanan 12. sınıf biyoloji öğretim programı dersini vermiş biyoloji öğretmenleri olmalarıdır. Buna göre araştırmanın çalışma grubu 72 biyoloji öğretmeninden oluşmaktadır. Araştırmanın çalışma grubunu oluşturan biyoloji öğretmenleri K1, K2,…,K72 şeklinde belirtilmiştir. Araştırmanın veri toplama aracı olarak biyoloji dersinin aktörleri olarak biyoloji öğretmenlerinin 12. Sınıf biyoloji öğretim programı hakkındaki görüşlerinin incelenmesi amacına yönelik görüşlerinin ele alındığı görüşme sorularının belirlenmesi ile ilgili alanyazın taraması yapılmış ve ayrıca alan uzmanlarının da görüşleri alınarak gerekli düzeltmeler yapılmıştır. Araştırmanın çalışma grubunu oluşturan katılımcıların demografik özelliklerini (cinsiyet, mesleki kıdem) 2 soru ve 12. Sınıf biyoloji öğretim programı hakkındaki görüşlerinin belirlenmesine yönelik 12 yarı yapılandırılmış açık uçlu sorudan oluşan görüşme formu kullanılmıştır. Bu sorular aşağıda verilmiştir:

- Uygulamakta olduğunuz 12. Sınıf biyoloji dersi eğitim programında yer alan kazanımlar hakkında ne söyleyebilirsiniz? Dersin amacına ve öğrenci düzeyine uygunluğu hakkında ne düşünüyorsunuz?
- Uygulamakta olduğunuz 12. Sınıf biyoloji dersi eğitim programında yer alan öğretim etkinlikleri hakkında ne söyleyebilirsiniz? Düzenlenen ders ve laboratuvar etkinlikleri kazanımları kazandıracak nitelikte midir? Değilse neden?
- Uygulamakta olduğunuz 12. Sınıf biyoloji dersinin içeriği hakkında neler söyleyebilirsiniz? İçerik kazanımları kazandıracak nitelikte midir?
- Uygulamakta olduğunuz 12. Sınıf biyoloji dersine ayrılan süre kazanımlara ulaşma bakımından yeterli midir? Değilse siz ne önerirsiniz?

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- Daha önce uygulamakta olduğunuz 12. Sınıf biyoloji dersi eğitim programını göz önünde bulundurduğunuzda şu an uyguladığınız 12. Sınıf biyoloji eğitim programı hakkında neler söyleyebilir siniz? Bu iki program arasındaki benzerlik ve farklılıklar nelerdir?
- Uygulamakta olduğunuz 12. Sınıf biyoloji dersi eğitim programının güçlü/üstün yönleri nelerdir? Bunların eğitime etkileri ya da katkıları nelerdir?
- Uygulamakta olduğunuz 12. Sınıf biyoloji dersi eğitim programının zayıf/sınırlı yönleri nelerdir? Bunlar nasıl ortadan kaldırılabilir?
- Uygulamakta olduğunuz 12. Sınıf biyoloji dersi eğitim programının ön koşul derslerle (örn. 9. Sınıf, 10. Sınıf, 11. Sınıf)uyumu hakkında ne düşünüyorsunuz?
- Uygulamakta olduğunuz 12. Sınıf biyoloji dersi eğitim programının uygulanmasında karşılaşılan güçlükler (öğrenciden, öğretmenden ya da programdan kaynaklanan) nelerdir? Sizce bu güçlükler nasıl ortadan kaldırılabilir?
- Uygulamakta olduğunuz 12. Sınıf biyoloji dersi eğitim programını zenginleştirmek için neler yapılabilir?
- Uygulamakta olduğunuz 12. Sınıf biyoloji dersi eğitim programında yer alan değerlendirme etkinliklerinin niteliği ve uygunluğu hakkında ne söyleyebilir siniz? Sizce 12. Sınıf biyoloji dersini değerlendirmede en uygun değerlendirme yaklaşımı hangisidir ve siz hangisini ne sıklıkla uygulamaktasınız?
- Uygulamakta olduğunuz 12. Sınıf biyoloji dersi için hazırlanmış olan ders kitabının yeterliliği konusunda ne düşünüyorsunuz? Yeterli değilse nasıl bir düzenleme yapılmalıdır?
- Araştırmada elde edilen verilerin analizinde içerik analizi kullanılmıştır. Bu analizin amacı, elde edilen verilerin araştırma kapsamındaki kavramalara ve ilişkilere ulaşılmasını sağlamaktadır. Buna göre, birbirine benzeyen verileri belirli kavramlar ve temalar çerçevesinde bir araya getirerek, bunların okuyucunun anlayabileceği bir biçimde organize ederek yorumlanması sağlanmaktadır (Yıldırım ve Şimşek, 2018). İçerik analizi, Thomas ve Hardene (2008) tarafından kullanılan analiz aşamaları ile birlikte nitel veri analiz programı MAXQDA 2018 kullanılarak yapılmıştır.

Sonuç. Araştırma kapsamında elde edilen sonuçlara göre; güncel 12. Sınıf biyoloji öğretimi programı biyoloji öğretmenlerinin çoğunluğu tarafından kazanım, öğretim etkinlikleri, ders içeriği açısından olumlu görüş bildirildiği söylenebilir.

Discussion and Conclusion. Araştırmanın sonuçlarına göre biyoloji öğretim programı kazanımlarını araştıran ve bu konuda çalışan bireylere öneriler şu şekilde sıralanabilir:

- Biyoloji öğretim programları kazanımları özellikle matematik ve fen bilimleri alanında gelişen ve değişen dünyaya ayak uydurarak güncellenmeli ve çağın gerektirdiği üst düzey düşünme becerilerine ağırlık verecek şekilde düzenlenmelidir.
- İlgili paydaşlarla (MEB ve üniversiteler) karma araştırma yöntemleriyle biyoloji öğretim programına yönelik düzeltmeler açısından derinlemesine değerlendirmeler yapılarak çözüm önerileri getirilebilir.
- Farklı ülkelerde uygulanan biyoloji öğretim programları analiz edilip ülkemizde uygulanan biyoloji öğretim programlarındaki eksiklikler saptanarak zenginleştirmeler sağlanabilir.

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Introduction

Biology, which is considered a life science, has become a cultural necessity in both our world and our country in today's conditions. Issues such as unhealthy industrialization, irregular urbanization, ecology, erosion, depletion of the ozone layer, environmental pollution, pest control, the formation and extinction of living things, genetic structures of living things, the interaction of living things with the environment, unbalanced nutrition, hunger, and uncontrolled population growth pose significant threats to our health (Yılmaz & Soran, 2003; Doğan, Kırvak, & Baran, 2004; Horasan, 2012; Çetin & Başbay, 2015). Addressing these problems, which are crucial to humanity, requires a proper biology education. Biology provides individuals not only with information about their own and their families' development, nutrition, health, and environment but also helps them understand important and interesting global developments in a logical framework, enabling others to comprehend biological life (MEB, 1997; MEB, 2007; Çakmak & Gürbüz, 2019).

Despite the significance of biology in our daily lives, several studies have indicated that students struggle with, fail in, have difficulty understanding, and even dislike the subject (Yeşilyurt & Gül, 2008; Gül & Yeşilyurt, 2010; Pehlivan & Köseoğlu, 2010; Atlı, 2019;). To overcome these negative aspects, biology classes should be made more relevant and enduring, rather than being mere memorization courses. For this purpose, educational activities such as making comparisons, interpreting information, conducting experiments to simplify abstract topics, developing concept maps, and organizing field trips should be implemented to enhance students' understanding of biology (Doğan, Kırvak, & Baran, 2004). In line with the constantly changing and developing conditions of today, biology education should be taken seriously for the development and future of natural sciences, and carefully planned and delivered to broaden the horizons of the younger generation.

As a discipline, biology has the most direct or indirect connections with other branches of science (Çilenti & Özçelik, 1991; Altunoğlu & Atav, 2005; Aslan & Kurt, 2021). It is distinct from other natural sciences in terms of both scientific and social aspects (Pehlivan & Köseoğlu, 2010; Kırbaç, 2016). Biology is interconnected with physics, chemistry, and other natural sciences, and advancements in biology and related fields greatly impact people's daily lives, society, and the environment (Çakmak & Gürbüz, 2019). Recognizing the importance of biology education in the modern world, developed countries are striving to improve the quality of biology education by continuously reviewing existing programs and effectively implementing the developed curricula.

Studies on biology education have revealed that both students and teachers face difficulties in teaching and comprehending this scientific subject. These challenges arise due to factors such as content overload, inadequate class hours, insufficient emphasis on experiments, lack of equipment, inadequate textbooks, crowded classrooms, insufficient physical facilities in schools, limited laboratory resources, inadequate number of teachers, low motivation of teachers or students, issues related to school and classroom culture, negative effects of university exams, student passivity and inclination towards rote learning, and insufficient focus on activities such as sightseeing and observation (Atav & Altunoğlu, 2005; Salman, 2006; Yeşilyurt & Gül, 2009; Gül & Yeşilyurt, 2010; Ersoy &Merter, 2012; Öztürk Akar, 2014; Çevik &Atıcı, 2015; Kırbaç, 2016;Çakmak & Gürbüz, 2019). To overcome these

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challenges and provide higher-quality education, it is necessary to develop student-centered and individualized biology teaching programs.

The efforts to develop a biology curriculum in Turkish education can be traced back to the Tevhid-i Tedrisat Law of 1924 (Ünal, Coştu &Karataş, 2004). Although the practice began in 1924 and lasted until the 1960s, the programs developed during the 1960s were used until the 1980s (Sönmez, 2018). The programs, which were primarily translations of developed countries' curricula without considering the conditions and specificities of Turkey, failed to meet the country's needs (Ünal, Coştu & Karataş, 2004; Atik, 2015). By the 1980s, a textbook-based education approach had replaced the modern education approach (Gezer, Köse, Durkan, & Uşak, 2003). In order to address the existing issues in the biology teaching program, a new curriculum was developed in 1985 (MEB, 1983). Subsequently, in 1997, the Board of Education approved the High School 1, 2, 3 curricula, which were developed by the "Education Research and Development Department" based on the Ministry of National Education and World Bank studies (MEB, 1997; Sönmez, 2018).

The Science and Technology Curriculum at the primary education level, which includes knowledge, attitudes, values, and understandings, served as an important foundation for biology, physics, and chemistry lessons after the popularity of the constructivist approach in 2004 (Çevik &Atıcı, 2015; Öztürk Akar, 2014; Çevik, 2015; Çakmak & Gürbüz, 2019). The three-year biology program was extended to four years, with the academic year of high schools gradually transitioning to four years starting from the 2005-2006 academic year, with the aim of restructuring secondary education (Çetin & Başbay, 2015; Atik, 2015). The Biology 12th Grade program was developed and published in 2007, and it was planned to be implemented from the 2011-2012 academic year (Akkaya Ercan, Tezcan, Karaca, Seylim & Arıkan, 2014). This program, introduced in 2013, follows a constructivist approach similar to the 1997 and 2007 programs, and emphasizes scientific process skills and student responsibility through a spiral framework (Akar, 2014; Atik, 2015). The new program also includes scientific research, understanding the nature of science, and applying scientific knowledge. It focuses on the process rather than the result, and introduces new assessment methods (Koçakoğlu, 2016). Based on national and international studies until 2017, the biology curriculum was further renewed in line with various educational approaches and was implemented from the 2018-2019 academic year.

With its constructivist approach, the biology curriculum aims to develop students who are researchers, inquirers, critical thinkers, problem solvers, lifelong learners, and possess the necessary skills, attitudes, values, and understandings to understand themselves and the events around them. Active learning experiences, such as critical thinking, creative thinking, problem-solving, research, analysis, evaluation, questioning, discussion, case studies, group work, projects, field trips, and experiments, are essential for students to acquire these characteristics (İzci, 2008; Çevik, 2014).

Program evaluation is crucial for ensuring the continuity and effectiveness of the education system. It aims to determine the functionality of the program, identify areas that require modification, assess the effectiveness of the current program, evaluate students' success in higher education and the job market, and achieve professional accreditation (Özdemir, 2009; Atik, 2015). In other words, curriculum evaluation compares measures of student behavior with the criteria stated in the goals to determine the robustness and efficacy of the curriculum (Büyükkaragöz, 1997; Demirel, 2007). Thus,

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program evaluation provides valuable information about the accuracy, suitability, reality, adequacy, effectiveness, efficiency, usefulness, applicability, and success of a program (Uşun, 2012; Erden, 1998). Therefore, curriculum evaluation is an indispensable element of curriculum development.

This research aims to evaluate the three units titled "Animal Physiology and Human," "Beginning of Life and Evolution," and "Rehabilitation and Protection of the Environment" in the 12th-grade biology curriculum, which were implemented from the 2011-2012 academic year (Çetin & Başbay, 2015). The evaluation aims to determine the extent to which the current biology curriculum achieves its goal of developing characteristics such as being a researcher-inquirer, critical thinking, decision-making skills, problem-solving, lifelong learning, self-recognition, and understanding of the environment. Through the perspectives of 12th-grade biology teachers, this study intends to uncover the effectiveness of students in acquiring knowledge, skills, attitudes, values, and understandings related to biology (Cepni and Çil, 2009; Çevik, 2014). The research problem is formulated as follows:

- What are the opinions of biology teachers, as the key actors in the biology course, about the 12th-grade biology curriculum?

Method

Ethical approval of the research was granted by Hacettepe University Ethics Committee on July 13, 2021, e E-76942594-600-00001649812. It was taken as a result of the decision no. Hacettepe University, 13 July 2021, No: e E-76942594-600-00001649812.

Research design

In this study, a case study design, which is one of the qualitative research methods, was employed to analyze the opinions of biology teachers regarding the 12th-grade biology curriculum. Case studies are commonly used in educational research as they provide a unique approach to exploring scientific inquiries. They involve an in-depth examination of one or more events, environments, programs, social groups, or interconnected systems. Case studies allow for the customization of research according to specific time and place, thereby offering a detailed understanding of a particular situation (Bogdan & Biklen, 1998).

The main objective of case studies is to gain insights into the dynamics and behaviors of the unit, phenomenon, or group being studied (Güven, 2001). In this research, the focus was on the opinions of biology teachers regarding the 12th-grade biology curriculum, and a single case study design was employed to explore this specific context with the same set of research questions. Single case studies aim to gain a comprehensive understanding of a single case and its constituent elements (Ersoy, 2016).

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Study group

The sampling method used in this study appears to be criterion sampling, which is a type of purposive sampling. Criterion sampling is employed when the aim is to analyze individuals, groups, events, or institutions that share a specific characteristic and are comparable to each other in detail (Patton, 2002). It involves forming a subgroup consisting of individuals who possess the desired feature, while excluding those who do not have that feature (Yıldırım & Şimşek, 2018).

In this research, the participants in the study group had one common characteristic: they were biology teachers who had previously taught or were currently teaching the 12th-grade biology curriculum. Therefore, the research sample comprises 72 biology teachers. The biology teachers included in the research sample are referred to as P1, P2,..., P72.

The demographic characteristics of the biology teachers who comprise the research sample are presented in Table 1.

Table 1.
Distribution of participants' demographic information

	Demographic Information	Frequency (f)	Percentage (%)
Gender	Man	22	%30,55
	Woman	50	%69,45
Professional seniority	Between 1-5 years	8	%11,11
	Between 6-11 years	21	%29,16
	Between 12-17 years	11	%15,27
	18 Years and Over	32	%44,45
Total		72	%100

Table 1 summarizes the demographic information of the study participants, including gender and professional seniority. It shows that 22 participants (30.55%) were male and 50 participants (69.45%) were female. In terms of professional seniority, 8 participants (11.11%) had 1-5 years of experience, 21 participants (29.16%) had 6-11 years, 11 participants (15.27%) had 12-17 years, and 32 participants (44.45%) had 18 or more years of experience. The total sample size was 72 participants.

Data collection tools

A literature review was conducted as part of the research process to gather data and inform the development of interview questions. The primary objective of the study was to examine the opinions of biology teachers, who are regarded as key actors in the biology course, regarding the 12th-grade biology curriculum. Furthermore, the literature review served to seek the perspectives of experts in the field, specifically faculty members from the Department of Curriculum and Instruction and the Department of Biology Education, in order to identify any necessary corrections or

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modifications. To achieve this, a thorough analysis of relevant scholarly articles, textbooks, and educational resources was undertaken. The literature review provided a comprehensive understanding of the current state of the 12th-grade biology curriculum, its strengths and weaknesses, and the challenges faced by biology teachers in its implementation. Drawing from this literature, appropriate interview questions were formulated to elicit the opinions, insights, and suggestions of the biology teachers regarding the curriculum. In addition to the insights gathered from the literature review, input was sought from esteemed faculty members specializing in curriculum development and biology education. The expertise of the faculty members from the Department of Curriculum and Instruction and the Department of Biology Education played a crucial role in assessing the adequacy and effectiveness of the 12th-grade biology curriculum. Their valuable perspectives provided valuable guidance in determining any necessary corrections or modifications to enhance the curriculum's quality and relevance. Overall, the combination of literature review and expert opinions from esteemed faculty members ensured a comprehensive evaluation of the 12th-grade biology curriculum and informed the necessary adjustments for its improvement.The interview questions in the research study were created based on the research objectives and the specific focus of the study, which was to explore the participants' views on the 12th-grade biology curriculum. The questions aimed to gather in-depth qualitative data and elicit rich insights from the participants. To ensure the validity and reliability of the interview questions, the following steps were taken:

Question development

The research team, consisting of experts in the field, carefully designed and developed the interview questions. The questions were aligned with the research objectives and intended to explore various aspects of the 12th-grade biology curriculum, including its achievements, teaching activities, content, time allocation, curriculum comparisons, strengths and weaknesses, compatibility with prerequisite courses, challenges in implementation, potential improvements, evaluation activities, and adequacy of the textbook.

Pilot testing

Prior to conducting the actual interviews, a pilot test was conducted with a small group of participants who were similar to the target population. The purpose of the pilot test was to evaluate the clarity, comprehensibility, and relevance of the interview questions. Feedback from the pilot test participants was collected and used to refine and improve the questions as necessary.

Expert review

The interview questions were reviewed by subject matter experts in the field of biology education and qualitative research methodology. These experts provided feedback on the content, wording, and appropriateness of the questions to ensure their validity and alignment with the research objectives.

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Validity and reliability studies

The interview questions were subjected to validity and reliability studies to ensure their robustness. This may have involved assessing the clarity and coherence of the questions, examining their alignment with the research objectives, and determining the extent to which they consistently elicited relevant and meaningful responses. The specific details of these validity and reliability studies were not provided in the given text.

Regarding the interview process, the text does not mention the duration of the interviews. However, it is stated that an interview form consisting of 12 semi-structured open-ended questions was used. Semi-structured interviews typically allow for flexibility in the conversation while covering specific topics.

The demographic characteristics (gender, professional seniority) of the participants in the research study group, as well as their views on the 12th-grade biology curriculum, were determined using an interview form consisting of 11 semi-structured open-ended questions. These questions are given below:

- What can you say about the achievements in the 12th-grade biology curriculum that you are applying? What do you think about the suitability of the course for the purpose and student level?
- What can you say about the teaching activities in the 12th-grade biology curriculum that you are applying? Are the lectures and laboratory activities organized in a way that will bring gains? If not why?
- What can you say about the topic of the biology course you're applying for in 12th grade? Does the content have the quality to bring gains?
- Is the time allocated for the 12th grade biology course you're taking enough to get the gains? If not, what would you suggest instead?
- What can you say about the 12th grade biology curriculum that you are applying now compared to the 12th grade biology curriculum that you were applying to previously? What are the similarities and differences between these two programs?
- What are the strengths/superiorities of the 12th grade curriculum you are applying? What are their effects or contributions to education?
- What are the weak/limited aspects of the biology curriculum you're applying in 12th grade? What can be done to get rid of them?
- What are your thoughts on the compatibility of the 12th grade biology curriculum you're using with the prerequisite courses (for example, 9th, 10th, and 11th grades)?
- What are the difficulties (from the student, the teacher, or the program) that you have faced in implementing the 12th grade biology curriculum that you are applying? How do you think these problems can be resolved?
- What can you do to improve the biology curriculum you're applying in 12th grade?
- What can you say about the quality and appropriateness of the evaluation activities in the 12th grade biology curriculum you are applying? What do you think is the most appropriate

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assessment approach in evaluating the 12th-grade biology lesson, and which one do you use and how often?

The Role of the Researcher

From the inception of the study until its completion and reporting, the researcher emphasizes adherence to scientific ethical principles. However, concerted efforts have been made to address the specific requirements and sensitivity associated with qualitative research.

Analysis of Data

Content analysis was employed to analyze the data obtained in the research. The purpose of this analysis was to examine the data and uncover the concepts and relationships within the scope of the study. To achieve this, similar data were grouped together based on specific concepts and themes, and they were organized and interpreted in a manner that would be comprehensible to the reader (Yıldırım & Şimşek, 2018). MAXQDA 2018, a qualitative data analysis software, was utilized to conduct the content analysis, following the analytical stages outlined by Thomas and Hardene (2008). These stages are described as follows:

Coding findings

In this stage, the findings, which could be direct quotations or fundamental concepts extracted from the primary research, were coded by systematically reading them line by line. Once all the findings were coded, the second stage could commence.

Developing descriptive themes

The codes obtained in the previous stage were compared and organized to establish a hierarchical tree structure based on their similarities and differences. Each group was assigned a thematic name, and the definitions and meanings associated with the grouped codes were encompassed within each theme.

Generation of analytical themes

While this phase remains grounded in the primary study's findings for theme development, it also generates novel interpretative frameworks and explanations that surpass the primary study. Descriptive themes derived from inductive analysis are used to address research questions that may have been temporarily unresolved. Through the comparison and discussion of descriptive themes with other researchers, more abstract analytical themes emerge.

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Ensuring validity and reliability

The crucial aspect in establishing the scientific rigor of the research lies in its reliability and validity. In qualitative research, examining the collected data in detail is an important criterion for ensuring validity, as it elucidates how the researcher arrived at the results (Yıldırım & Şimşek, 2018).

Themes were determined through content analysis, and codes were extracted to conduct a suitable content analysis for qualitative research, presenting the findings accordingly. The data was analyzed by defining themes and sub-themes in alignment with the study's objectives. To ensure the research's reliability, the data obtained and the opinions of two experts were consulted. The reliability formula proposed by Miles and Huberman (1994) was employed, which is calculated as follows:

Reliability = [Agreement / (Agreement + Disagreement)] x 100
= [936 / (936 + 104)] x 100= [936 / 1040] x 100 = 0.90 x 100 = 90

Validity in qualitative research refers to the extent to which the findings accurately represent the phenomenon being studied. Ensuring validity involves several strategies and techniques to enhance the credibility and trustworthiness of the research. In the study described, the following measures were taken to ensure validity:

Triangulation

Triangulation is the use of multiple sources, methods, or researchers to cross-validate and confirm the findings. In this study, data were collected from various sources, such as interviews, observations, or documents, to provide a comprehensive understanding of the research topic. Multiple researchers were involved in the analysis process, and their interpretations and conclusions were compared to ensure consistency and reliability.

Member checking

Member checking, also known as respondent validation, involves sharing the research findings with participants to verify the accuracy and authenticity of the interpretations. In this study, the researchers consulted with the participants, presenting them with the preliminary findings and seeking their feedback and input. This process allowed for participant perspectives and insights to be incorporated, enhancing the validity of the research.

Detailed documentation

The researchers maintained detailed documentation of the research process, including the research design, data collection procedures, analysis techniques, and interpretations. This documentation ensures transparency and allows for scrutiny and evaluation by other researchers or experts, enhancing the trustworthiness and validity of the study.

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Reflexivity

Reflexivity refers to the researchers' ongoing awareness of their own biases, assumptions, and preconceptions that may influence the research process and findings. The researchers in this study engaged in reflective practices, regularly reflecting on their own perspectives and potential biases, and considering how these may have influenced the interpretation of the data. By acknowledging and addressing potential biases, the researchers aimed to enhance the validity and credibility of the study.

Peer review

The research findings, interpretations, and conclusions were subjected to peer review by experts in the field. This external evaluation helps to identify any potential weaknesses, biases, or alternative interpretations, contributing to the overall validity and rigor of the research.

By employing these strategies, the researchers sought to ensure the validity of the study by promoting credibility, transferability, dependability, and confirmability. These measures aim to enhance the trustworthiness and robustness of the research findings, increasing confidence in the validity of the study.

Results

In Table 2, the opinions of biology teachers regarding the compatibility of the achievements of the 12th-grade biology curriculum with the purpose of the lesson and the level of the student are presented.

Table 2.
Achievements of the 12th grade biology curriculum

Theme	Codes	Frequency (f)
Achievements	Suitable for student levels and requirements	32
	Not suitable for student levels and requirements	22
	Deficiencies in the structuring of the topics in the units	34
Total		88

According to Table 2., when the opinions of the participants about the achievements of the 12th-grade biology curriculum are considered as a whole, they are evaluated as 1 theme in terms of function and concept. The theme is Achievements (88). Some examples of participant responses to the codes of this themare given below:

"*Suitable and Sufficient*" **(Suitable for Student Levels and Requirements)** (P1)

"*Unnecessary details and information are given*" **(Not Suitable for Student Level and Requirements)** (P2)

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*"It is appropriate, but the information is in the air when the important reactions in photosynthesis and respiration are not adequately explained."***(Suitable for Student Levels and Requirements; Deficiencies in the Structuring the Topics in the Units)** (P3)

*"The achievements of the 12th grade are difficult for the student who is preparing for university. It is good to introduce animal physiology to the 11th-grade curriculum. The removed evolution topic should be reintroduced to the 12th-grade curriculum."***(Deficiencies in the Structuring of the Topics in the Units)** (P5)

*"It is a program far from student interest and level. Since high school 1st and 2nd-grade students are not given time and achievements to create sufficient biology infrastructure, their levels are far behind what is expected. The program is STEM-based with an abstract structure. Unfortunately, since the program does not have stem and biology laboratories in schools, it doesn't meet with reality. It has been prepared far from the 2023 targets."***(Not Suitable for Student Levels and Requirements; Deficiencies in the Structuring of the Topics in the Units)** (P9)

"In all units, there is sometimes high-level information and unfortunately insufficient information in places" **(Not Suitable for Student Levels and Requirements; Deficiencies in the Structure of the Topics in the Units)** (P50)

"I find the achievements sufficient. Although the new curriculum on the plant only has been narrowed, I still find it unnecessary for the information to be this deep." **(Suitable with Student Levels and Requirements; Deficiencies in the structuring of the Topics in the units)** (P69)

The opinions of biology teachers about the teaching activities of the 12th-grade biology curriculum are given in Table 3.

Table 3.
Teaching activities of the 12th grade biology curriculum

Theme	Codes	Frequency (f)
Teaching activities	Being appropriate for course achievements	24
	Inappropriate	32
	Neglected/Invalid Activities Due to Lack of School Physical Features/Equipment	17
	Class-Level Issues	12
	Being Oriented to the Knowledge Level	1
Total		86

When taken as a whole, the participants' opinions on the achievements of the 12th-grade biology curriculum were evaluated as one themes in terms of function and idea, as shown in Table 3. This themes is Teaching Activities (86). Some examples of participant responses to the codes of this theme are given below:

*"It is qualified, yes"***(Being Appropriate for Course Achievements)** (P1)

"No, it's not enough" **(Inappropriate)** (P2)

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*"Qualified, but there are no laboratories in every school, and 12th-grade students act a little more exam-oriented, making the experimental environment more difficult."***(Being Appropriate for Course Achievements; Neglected/Invalid Activities Due to Lack of School Physical Features/Equipment; Class-Level Issues)** (P4)

*"Some of the lab activities are not appropriate for the grade level. Some are too simple. Moreover, events cannot be held to train a busy schedule."***(Neglected/Invalid Activities Due to Lack of School Physical Features/Equipment; Class-Level Issues)** (P5)

"Since we are in an exam-oriented system, we cannot include activities much"(**Class-Level Issues**) (P10)

*"Events should be organized according to the laboratory-free environment. There are no laboratories in schools."***(Neglected/Invalid Activities Due to Lack of School Physical Features/Equipment)** (P11)

"We can't do many activities since there is no laboratory. Additionally, 12th grade students prefer solving tests to activities. Some activities are below the class level" **(Neglected/Invalid Activities Due to Lack of School Physical Features/Equipment**; **Class-Level Issues)** (P21)

*"It is not based on interpretation, it is always information-based"***(Being Oriented to the Knowledge Level)** (P29)

*"The activities provide the competence to solve the test questions, reinforcing the subject for this group of students who will take the exam this year."***(Being Appropriate for Course Achievements)** (P69)

The opinions of biology teachers about the course contents of the 12th-grade biology curriculum are given in Table 4.

Table 4.
Course contents of the 12th grade biology curriculum

Theme	Codes	Frequency (f)
Course contents	The course content is suitable for the achievements	34
	Deficiencies in course contents in some units	30
	Scientific errors in course contents in some units	8
Total		72

When the participants' opinions on the achievements of the 12th-grade biology curriculum are examined as a whole, they are evaluated as one themes in terms of function and concept, according to Table 4. This themes is Course Contents (72). Some examples of participant responses to the codes of this theme are given below:

*"Achievements should stay like this. There is no need for more."***(The Course Content is Suitable for the Achievements)** (P1)

*"Yes it is appropriate"***(The Course Content is Suitable for the Achievements)** (P2)

"The achievements given in animal physiology have been removed, only human physiology is given. This dispels the opportunity for students who are interested in science to make comparisons. The

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*beginning of life was the subject that led the students to query, but now it has been removed"***(Deficiencies in the Course Contents in Some Units)** (P5)

*"I think the content is adequate, but the scientific errors in the books should be corrected"***(Scientific Errors in Course Contents in Some Units)** (P61)

"The achievements are less and the content is less, the current content is below the achievements" **(Deficiencies in the Course Contents in Some Units)** (P67)

"Content needs to be developed." **(Deficiencies in Course Contents in Some Units)** (P69)

The opinions of biology teachers about the adequacy of the 12th-grade biology curriculum lesson duration in terms of achieving the achievements are given in Table 5.

Table 5.
Adequacy of 12th grade biology curriculum course duration in reaching achievements

Theme	**Codes**	**Frequency (f)**
Adequacy of course duration in terms of reaching achievements	The course duration is sufficient for reaching the achievements	25
	The course duration is ınsufficient for reaching the achievements	47
Suggestions for reaching the learning achievements of the course duration	The requirement of ıncreasing the course duration	42
	Lab/event hour requirement	12
	Reducing curriculum content	1
	Balanced distribution of course topics by grade levels	1
Total		128

When the participants' opinions on the suitability of the 12th-grade biology curriculum course duration in terms of achieving the objectives are taken as a whole, they are divided into two themes in terms of function and concept, as shown in Table 5. These themes are Adequacy of Course Duration in terms of Reaching Achievements (72) and Suggestions for Reaching Achievements of Course Duration (56).

Some examples of participant responses to the themes of the Adequacy of Course Duration in terms of Reaching Achievements themes (72) are given below:

*"It is sufficient"***(The Course Duration is Sufficient For Reaching the Achievements)** (P1)

"It is not enough, additional laboratory or activity hours should be set" (**The Course Duration is Insufficient For Reaching the Achievements**) (P4)

"Not enough time. Some desired achievements may be overlooked because of the intensity in terms of content and achievements." (**The Course Duration is Insufficient For Reaching the Achievements**) (P63)

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"Not enough time. Course hours should be increased to three hours or supported by elective courses."(**The Course Duration is Insufficient For Reaching the Achievements**) (P69)

Some examples of participant responses to the themes of the Suggestions for Reaching Achievements of the Course Duration (56) themes are given below:

"There should be more course hours" **(The Requirement of Increasing the Course Duration)** (P2) and "*Additional laboratory or activity time should be set*" **(Lab/Event Hour Requirement)** (P4)

*"Under the name of the application of the biology course, the additional hour of the lessons should come again. Activities can be done in the biology practice lesson"***(The Requirement of Increasing the Course Duration)** (P5)

*"I think it is sufficient, but it would be much more efficient if there was also a field and lab course"***(Lab/Event Hour Requirement)** (P6)

"Definitely not, time is insufficient. 1 more lesson hour should be added" **(The Requirement of Increasing the Course Duration)** (P60)

"The achievements within the time allocated to education are not sufficient for obtaining correct information and improving the interpretation of the students. In this context, either the course hours should be increased or the 12th-grade curriculum subjects should be reduced. Biology subjects should be distributed evenly in 9th, 10th, 11th, and 12th grades." **(The Requirement of Increasing the Course Duration; Reducing Curriculum Content; Balanced Distribution of Course Topics by Grade Levels)** (P65)

The views of biology teachers about the similarities and differences of the 12th-grade biology curriculum, which was applied before and currently applied, are given in Table 6.

Table 6.
Similarities and differences between the previously ımplemented and the presently ımplemented 12th grade biology curriculum

Theme		Codes	Frequency (f)
Program compliance	philosophy	Currently implemented program's achievements	37
		Previously implemented program's achievements	21
Differences separation	in unit	Old program's unit separation convenience	25
		No difference between programs	2
Total			85

According to Table 6., the participants' opinions on the similarities and differences of the previous and current 12th-grade biology curriculums were evaluated as a two themes in terms of function and concept when taken as a whole. This themesareProgram philosophy compliance (58) and Differences in unit separation (27). The responses to the themes of the created themes are given below:

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Some examples of participant responses to the theme of the Program philosophy compliance (58) are given below:

*"The achievements were messy at first. Now it is more limited and can be explained"***(Currently implemented program's achievements)** (P1)

*"Currently, the achievements of the textbook content are more balanced, they were not relevant before"***(Currently implemented program's achievements)** (P2)

"It was better to give the topic of systems in the 12th grade" **(Previously implemented program's achievements)** (P3)

"There are many similarities, the differences are that the topics are diluted and more understandable" **(Currently implemented program's achievements)**(P4)

*"The evolution unit has been removed, this unit can be given in the 11th grade."***(Previously implemented program's achievements)** (P5)

"The previous program was much more full and inquiry-oriented, the previous program was better in terms of thinking, questioning and opening horizons" **(Previously implemented program's achievements)** (P7)

Some examples of participant responses to the theme of the Differences in unit separation (27) are given below:

"There is no fundamental difference between these two programs." **(No difference between programs)** (P11)

*"There had to be evolution and behavior topics. Since the classification of plants is not sufficient in the 9th grade, it is difficult to understand in the 12th grade as well"***(Old program's unit separation convenience)** (P23)

"The topics of respiration and photosynthesis were previously in 11th grade. The fact that the subjects of respiration and photosynthesis together with human physiology were in the 11th grade made things very difficult. In other words, I can say that it was better to include these subjects in the 12th grade… In short, the biology program currently being applied in the 12th grade is suitable for students to understand and to learn during the university preparation process." **(Old program's unit separation convenience)** (P51)

*"I think that due to the missing titles, students don't use their questioning and reasoning skills anymore and they are directly forced to memorization."***(Old program's unit separation convenience)** (P62)

*"They have similar content in terms of achievements. Only population genetics and evolution topics have been taken out."***(No difference between programs)**(P69)

The opinions of biology teachers about the strengths/superiorities of the current 12th-grade biology curriculum are given in Table 7.

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Table 7.
Strengths/superior aspects of the current 12th grade biology curriculum

Theme	Codes	Frequency (f)
Strengths/superior aspects of the current 12. Grade biology curriculum	Being functional	29
	Relating the subjects to daily life	25
	Meaningful learning	21
	Provides learning by doing and experiencing	6
	Being associated with scientific and current ıssues	11
	Not functional and meaningful	9
	Compliance with the principle of economics	11
	Total	112

When the participants' opinions on the strengths/superior parts of the current 12th-grade biology curriculum are evaluated as a whole, they are evaluated as one theme in terms of function and concept, according to Table 7. This themes is the Strengths/Superior Aspects of the Current 12. Grade Biology Curriculum (112). Some examples of participant responses to the codes of the created themes are given below:

*"Having a Sufficient Achievement"***(Being Functional)** (P1)

*"Holding on to life, changing perspectives, discovering that living things are not ordinary, raising awareness for the moment we call first aid"***(Relating Subjects to Daily Life; Meaningful Learning)** (P2)

*"Giving information about protein synthesis and biotechnological studies facilitates adaptation to today's world"***(Relating Subjects to Daily Life; Meaningful Learning)** (P3)

*"Strengths of teaching with examples by doing and living"***(Provides Learning by doing and experiencing)** (P4)

*"The introduction of biotechnology and genetic engineering is its current strength. It is useful to follow their understanding of future studies"***(Being Associated with Scientific and Current Issues)** (P5)

"I don't see a strong and superior aspect other than adding a few up-to-date information to our practice" (**Being Associated with Scientific and Current Issues**; **Not Functional and Meaningful**) (P7)

"Low number of units" **(Compliance with the Principle of Economics)** (P10)

*"Being simpler. Students are drowning in details."***(Compliance with the Principle of Economics)** (P14)

*"With the energy conversion unit, they realize the importance of their environment, nature, and other living things much better. Especially after the plant biology unit, they look at plants more consciously and with a higher level of awareness"***(Relating the Subjects to Daily Life; Meaningful Learning)** (P16)

*"Biotechnology genetic engineering topics are good. It enables students to have an idea about the field choices at the university. We can also discuss current scientific developments."***(Being Associated with Scientific and Current Issues; Meaningful Learning**) (P17)

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*"Simple, easy, achievements are appropriate"***(Compliance with the Principle of Economics)** (P26)

*"Unfortunately, there is no superiority in the program, the 12th-grade program does not match the exam reality."***(Not Functional and Meaningful)** (P43)

*"I think its strength is that it includes more current and life-related topics."***(Relating the Subjects to Daily Life; Meaningful Learning, Being Associated with Scientific and Current Issues)** (P44)

"Abstract and non-experimental subjects can be easily understood within the age group of the students." **(Being Functional; Meaningful Learning)** (P45)

*"The fact that the subject of biotechnology is in the 12th grade is appropriate in terms of the students' general evaluation of biological knowledge. At the same time, biotechnology has become very significant in recent years, and we observe it in drug or vaccine development studies during this pandemic process. When such an important subject is in the 12th grade, the student comes ready to understand its importance."***(Relating the Subjects to Daily Life, Meaningful Learning, Being Associated with Scientific and Current Issues)** (P51)

"Since it was simplified, it became easier for the student to perceive" (**Compliance with the Principle of Economics**) (P64)

"Thanks to the inclusion and applicability of experiments, the student can easily assimilate the subject and get closer to the biology lesson. Additionally, colorful visuals have a positive effect on ensouling the subject." (**Compliance with the Principle of Economics**; **Being Functional**;**Meaningful Learning**) (P68)

*"Values education and gaining some more achievements are its strengths. I find values education very vital for negative events in society today. It is very important that the achievements are included in quality rather than quantity. Rather than filling the student with the knowledge, it should be applicable in daily life. It is more significant to establish environmental awareness."***(Relating the Subjects to Daily Life; Meaningful Learning)** (P71)

The views of biology teachers about the weak/limited aspects of the current 12th-grade biology curriculum are given in Table 8.

Table 8.
Weak/limited aspects of the current 12th-grade biology curriculum

Themes	**Themes**	**Frequency (f)**
Weak/limited aspects of the current 12th-grade biology curriculum	Less lesson hours	5
	Topics that have no questions in university admission test	1
	Detailed course topics	12
	The problems of the exam-oriented grade level	5
	Lack of laboratory/field applications	6
	Failure of functional	12
	Meaningful learning	10
	Not conforming to the principle of economics	9

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	No weaknesses/limitations of the program	3
	The topics are not associated with daily life	7
Total		70

When the participants' opinions on the weak/limited components of the current 12th-grade biology curriculum are taken as a whole, they are evaluated as one themes in terms of function and concept, according to Table 8. This themes is the Weak/Limited Aspects of the Current 12th-grade Biology Curriculum (70). Some examples of participant responses to the themes of the created themes are given below:

*"The attractiveness of course hours is perceived as insignificant by OSYM (student selection and placement center) since the number of questions is low"***(Less Lesson Hours; Topics That Have No Questions in University Admission Test)** (P2)

*"I think there are unnecessary details about plants. While teaching people at 11. grade, we teach themselves and their nature, health. It is beautiful but at 12. grade, botany is very detailed, not all of these children will be plantation owner or agriculturalists"***(Detailed Course Topics)** (P3)

*"Exam stress should reduce students' learning skills and exam anxiety should be eliminated"***(The Problems of the Exam-Oriented Grade Level)** (P4)

*"You don't have time to do lab and field applications. It would be better if there were lab and field applications courses instead of unnecessary elective courses."***(Less Lesson Hours; Lack of Laboratory/Field Applications)** (P6)

*"The program does not exceed the level of knowledge in the books prepared accordingly. When it is a set of the simply listed information, there is no choice but to memorize it. Information should be organized in such a way as to be tested with logic, questioned and understand the nature of science"***(Failure of Functional; Meaningful Learning)** (P7)

*"The locations of the subjects can be changed. There might be more easily understandable topics for the last year."***(Not Conforming to the Principle of Economics)** (P8)

*"There are no weaknesses."***(No Weaknesses/Limitations of the Program**) (P14)

"The issues that will be associated with life should be emphasized." **(Failure of Functional; Meaningful Learning)** (P44)

"The harmony with daily life can be increased more" **(The Topics Are Not Associated With Daily Life)** (P64)

The opinions of biology teachers about the compatibility of the current 12th-grade biology curriculum with the prerequisite courses are given in Table 9.

Table 9.
Compatibility of current 12th grade biology curriculum with prerequisite courses

Theme	**Codes**	**Frequency (f)**
Compliance of current 12th grade biology curriculum with prerequisite courses	Compliant with the integrity principle	35
	Prerequisites for 9th and 10th grade courses	15
	9th grade courses provide prerequisites	9

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	Non-compliance with the ıntegrity principle	13
Total		72

When the participants' opinions on the compatibility of the current 12th-grade biology curriculum with prerequisite courses are viewed as a whole, it is evaluated as one themes in terms of function and concept, according to Table 9. This theme is the Compliance of Current 12th Grade Biology Curriculum with Prerequisite Courses (72). Some examples of participant responses to the codes of the created themes are given below:

*"I think it is suitable for 9. and 10. Grade general biology. I think that there should be an application course in the 11th grade"***(Prerequisites for 9th and 10th Grade Courses)** (P5)

*"Prerequisite topics are given in the 9th grade."***(9th Grade Courses Provide Prerequisites)** (P6)

"There is no biology in 12th grade in all high schools, so I think that the subjects should be prioritized and ordered again according to high school types" **(Non-Compliance with the Integrity Principle)** (P7)

*"9th grade is also not enough, but no details can be given for the students who come first. If the teacher explains the logic of the subjects in 9th and 10th grade and gives detailed information, it will be easier for the students to understand the subjects of 12th grade"***(Prerequisite for 9th and 10th Grade Courses)** (P23)

*"The curriculum is compatible with the subjects given in the pre-classes. 9th and 10th grades teach basic subjects. However, the real problem is how successful these subjects are in giving and how well they fit the target. Despite the fact that the subjects are very suitable, especially in the 9th grades, the lack of lesson hours causes the information to be confused without clarification. This situation reduces success in other classes and makes it difficult to reach the goal."***(Prerequisite for 9th and 10th Grade Courses)** (P62)

The opinions of biology teachers about the difficulties encountered in the application of the current 12th-grade biology curriculum are given in Table 10.

Table 10.
Difficulties encountered in the application of the current 12th grade biology curriculum

Theme		Codes	Frequency (f)
Difficulties encountered in the application of the current 12th grade biology curriculum	Difficulties resulting from the education program	Not conforming to the principle of economics	21
		Non-functional	19
		Less lesson hours	10
	No difficulty encountered in the application of the program		6
	Difficulties due to the school environment	Lack of laboratory conditions	7

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	Difficulties due to the students	Failure of the student to actively participate in learning activities	13
		Student readiness level	3
		Total	79

When the participants' views on the challenges faced in implementing the current 12th-grade biology curriculum are taken as a whole, they are evaluated as one themes in terms of function and concept, according to Table 10. This theme is Difficulties Encountered in the Implementation of the Current 12th-grade Biology Curriculum (79). Some examples of participant responses to the themes of the created codes are given below:

*"The teacher's lack of material and equipment is the perception that the student will look at biology with the eye of memorization and only look for the exam"***(Difficulties Resulting from the Education Program [(Lack of Teaching Materials/Equipment; Not Conforming to the Principle of Economics; Non-functional; Failure of the Student to Actively Participate in Learning Activities)])** (P1)

"I think the curriculum should be simplified, the topics should be finished in 9th, 10th, and 11th grades and they should prepare for the exam with a general repetition at 12th grade. After all, we were finishing these subjects in 3 years" **(Difficulties Resulting from the Education Program [(Not Conforming to the Principle of Economics)]** (P3)

"I think there is no difficulty to be eliminated" **(No Difficulty Encountered in the Application of the Program)** (P4)

*"I think that the 12th-grade subjects should have a general repetition nature"***(Difficulties Resulting from the Education Program [(Not Conforming to the Principle of Economics)]** (P5)

"Plant biology topics are unnecessarily detailed" (**Difficulties Resulting from the Education Program[(Not Conforming to the Principle of Economics)]** (P15)

*"Laboratory conditions should be improved"***(Difficulties Due to School Environment [(Lack of Laboratory Conditions)]** (P19)

*"Class hours definitely need to be increased"***(Difficulties Resulting from the Education Program [(Less Lesson Hours)]** (P30)

"A curriculum taught in the shadow of üniversity exam" **(Difficulties Resulting from the Education Program [(Not Conforming to the Principle of Economics)]** (P35)

*"Student's achievements are not enough"***(Difficulties Due to the Students [(Student's Readiness Level)]** (P38)

*"We don't have a lot of opportunities to experiment. The topics are voluminous."***(Difficulties Due to the School Environment [(Lack of Laboratory Conditions)]; Difficulties Resulting from the Education Program [(Not Conforming to the Principle of Economics)]** (P44)

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"Subjects are difficult to learn since they are abstract, so we need to make the classroom environment more compatible with learning" **(Difficulties Due to the School Environment [(Non-functional; Failure of the Student to Actively Participate in Learning Activities)])** (P64)

Biology teachers' suggestions for enriching the current 12th-grade biology curriculum are given in Table 11.

Table 11.
Suggestions for enriching the current 12th grade biology curriculum

Theme	Codes	Frequency(f)
Suggestions for enriching the current 12th grade biology curriculum	Active use of course resources/materials	1
	Developing inquiry skills of learners	8
	Making laboratory / field applications	15
	Arrangement of class hours	10
	Being associated with scientific and current ıssues	18
	Those who think the education program is sufficient	4
	Arrangement in accordance with the principle of economy	12
	Total	68

When taken as a whole, the participants' suggestions to enhance the current 12th grade biology curriculum were evaluated as one themes in terms of function and concept, according to Table 11. This theme is Suggestions for Enriching the Current 12th Grade Biology Curriculum (68). Some examples of participant responses to the themes of the created codes are given below:

*"Examples, more active use of course resources, and visual animations"***(Active Use of Course Resources/Materials; Use of Audio/Visual Lesson Tools)** (P4)

*"The questioner can be enhanced with ethical principles"***(Developing Inquiry Skills of Learners)** (P5)

"Since they are a test group, they spend more time doing tests. Going out into nature, examining plants, being respectful to nature will be much more efficient with field practices and laboratory studies." **(Making Laboratory/Field Applications)** (P6)

*"Course hours should be arranged as 3+2 theoretical and practical"***(Arrangement of Class Hours)** (P7)

*"More opportunities should be given to current events and issues"***(Being Associated with Scientific and Current Issues)** (P8)

*"Titles related to the philosophy of biology can be put."***(Being Associated with Scientific and Current Issues)** (P9)

*"The program is sufficient"***(Those Who Think the Education Program Is Sufficient)** (P10)

*"Increase of class hours is a must"***(Arrangement of Class Hours)** (P15)

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*"Subject content can be given item by item. Important notes can be included in the book with emphasis. It can be supported by questions from the university exam."***(Arrangement in accordance with the principle of economy)** (P24)

*"Teachers can be trained at universities to design new activities"***(Failure of Meaningful Learning)]))** (P61)

The opinions of biology teachers about the quality and appropriateness of the evaluation activities of the current 12th-grade biology curriculum are given in Table 12.

Table 12.
The quality and appropriateness of the evaluation activities of the current 12th-grade biology curriculum

Theme	Codes	Frequency (f)
The quality and appropriateness of the evaluation activities of the current 12th-grade biology curriculum	Those who think evaluation activities are appropriate	15
	Developing students' thinking skills	35
	Being exam-oriented due to university entrance exams	20
	Types of activities for the formation of high-level achievements	10
Total		80

When the opinions of the participants about the quality and appropriateness of the evaluation activities of the current 12th-grade biology curriculum are taken as a whole, they are evaluated as one themes in terms of function and concept, according to Table 12. This themes is the Quality and Appropriateness of Evaluation Activities of the Current 12th-grade Biology Curriculum (80). Some examples of participant responses to the themes of the created themes are given below:

*"Appropriate"***(Those Who Think Evaluation Activities Are Appropriate)** (P1)

"Due to multiple-choice TYT and AYT" ***(*Being Exam-Oriented Due to University Entrance Exams)** (P3)

*"Evaluation is done by exam. Evaluation can be made with research assignments"***(Developing Students' Thinking Skills)** (P5)

*"The evaluation part can be increased a little more and can be diversified."***(Types of Activities for the Formation of High-Level Achievements)**(P11)

*"The activities in the evaluation section are generally comprehension-oriented, but there are also activities at the analysis-synthesis level. In the evaluation phase, I usually make evaluations with open-ended questions and activities at the level of analysis-synthesis"***((Developing Students' Thinking Skills; Types of Activities for the Formation of High-Level Achievements))** (P16)

"The system forces to apply absolute evaluation and of course, I would like to be able to apply formative evaluation. Unfortunately, the biggest problem of the generation we graduated from is rote learning…the ability of questioning and reasoning is almost non-existent." **(Being Exam-Oriented Due**

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to University Entrance Exams; Types of Activities for the Formation of High-Level Achievements) (P62)

Discussion, Conclusion and Suggestions

Education, being a vital component of society and influenced by scientific and technological advancements, has led to the development of various educational perspectives. Among these, the curriculum stands as a fundamental element in preparing present and future generations (Demirel, 2005; Susam & Demir, 2020; Çeliktaş & Sönmez, 2021). Therefore, the curriculum assumes a new dimension in terms of its content, goals, desired knowledge and skills, as well as the role of technology in lifelong learning. In this era of rapid technological development, the creation of versatile educational programs that foster critical thinking, questioning, research, practical application, and interdisciplinary approaches becomes essential in contributing to individuals' professional lives and the country's development (Özmen, 2018; Fer, 2019; Bozkurt, 2020; Öztürk & Kafadar, 2020; İmrol, Dinçer, Güldenoğlu, & Babadoğan, 2021). Within the research's scope, the opinions of biology teachers, who are key stakeholders in the biology course, regarding the 12th-grade biology curriculum were assessed in light of relevant literature.

The majority of biology teachers expressed that the current 12th-grade biology curriculum's achievements are not suitable for the lesson's objectives and students' proficiency levels. Achievements represent the elements aimed at creating valid curricula and adapting these programs to meet the demands of the time. Consequently, the objectives established during the curriculum development process should be directly linked to the achievements. The acquisition of biology knowledge by individuals should be designed in line with objectives that promote creative thinking, critical perspectives, the development of various problem-solving methods, and practical goals to keep pace with today's advancements (Ayvacı & Türkdoğan, 2010; Çelikkaya, Oktay, Yazar, Bayrakçeken & Canpolat, 2021). Although the recent updates in the 12th-grade biology curriculum have reduced the number and weight of achievements, this change was found to be appropriate by almost half of the teachers but not by the other half.

Moreover, the majority of biology teachers indicated that the teaching activities in the current 12th-grade biology curriculum are insufficient. Teaching activities, when carried out using a student-centered approach, facilitate the interpretation, development, and reconstruction of new knowledge by connecting it with students' existing concepts and understanding (Gözütok, 2006). However, ensuring effective teaching and learning through these activities requires careful planning and implementation (Saracaloğlu & Kayabaş, 2007). According to teachers' opinions, the content of the 12th-grade biology curriculum should be expanded by incorporating engaging and diverse activities with a student-centered approach.

Regarding the content of the 12th-grade biology curriculum, the majority of teachers considered it appropriate for achieving the desired learning outcomes. Course content comprises statements that describe or list measurable and required knowledge, skills, and competencies. It serves to demonstrate that students have successfully completed a course and achieved the intended

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learning outcomes. Therefore, appropriate course content implies the integration of high-level thinking skills with the subject matter and can manifest as observable behavior, skills, or practical knowledge after course completion (Harden, 2002; Hartel & Foegeding, 2004; Kennedy, Hyland, & Ryan, 2006; Melton, 2014; Turan & Koç, 2021). However, the majority of biology teachers also expressed that the course length of the 12th-grade biology curriculum is insufficient to cover all the desired achievements. Depending on the selected course hours, high schools allocate 2, 3, or 4 hours per week for teaching biology. Consequently, due to limited course hours, certain topics, such as genetics, protein synthesis, energy conversion in living organisms, plant biology, and ecology, may not receive adequate attention from students who are simultaneously preparing for university entrance exams.

When comparing the previous and current 12th-grade biology curricula, the majority of biology teachers perceived the current curriculum as being more aligned with the philosophy of the biology course. This could be attributed to the fact that the previous curriculum had a more extensive content. Based on this context, teachers rated the strengths and advantages of the current curriculum as functional. The knowledge categories presented by teachers should be transferred from short-term memory to long-term memory, ensuring their permanence and practicality. A functional curriculum is considered an effective means to achieve this objective (Yapıcı, 2011; Atlı, 2019; Et & Gömleksiz, 2021). Conversely, the weak aspects of the 12th-grade biology curriculum, according to the majority of teachers, include excessively detailed topics and a lack of practical and meaningful learning experiences.

Regarding the compatibility of the current 12th-grade biology curriculum with prerequisite courses, the majority of biology teachers perceived a high degree of alignment. This viewpoint reflects the belief that learning becomes more efficient and meaningful when educational goals are organized to develop individuals as contributors to societal progress and integrate contemporary scientific information (Aydın & Aslan, 2021; Bilen, 2002; Erden, 1998). However, teachers also highlighted challenges related to implementing the current curriculum, asserting that it does not align well with the principle of economy and fails to provide a functional learning experience. To establish better coherence between subjects, basic concepts taught in previous courses should be connected horizontally and integrated in a vertical context, facilitating the learning of subsequent topics. This approach minimizes unnecessary repetition and enables efficient acquisition of knowledge. To enrich the current 12th-grade biology curriculum, teachers suggested incorporating scientific and current issues, organizing laboratory and field applications, and ensuring alignment with the principle of economy.

The majority of biology teachers asserted that evaluation activities in the current 12th-grade biology curriculum are primarily exam-oriented, aiming to strengthen students' thinking skills. Assessments that promote critical thinking and meaningful learning help students understand concepts and gain mastery over the course content. Furthermore, evaluation activities should be designed to foster application and research skills related to the learning outcomes, encouraging students to question and critically analyze assessment tasks (Aslan Efe & Efe, 2018; Atlı, 2019; Aslan & Kurt, 2021). The exam-oriented nature of the evaluation activities is considered beneficial for students

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preparing for university entrance exams and teachers who face challenges in delivering the curriculum effectively.

Regarding the textbook used in the current 12th-grade biology curriculum, the majority of teachers considered its content to be appropriate. This finding suggests that the recent updates to the curriculum have alleviated the subject load, addressing the concerns related to content intensity.

Based on the research findings, the majority of biology teachers expressed positive opinions regarding the learning outcomes, teaching activities, and course content in the current 12th-grade biology curriculum. In light of these findings, several suggestions can be made for researchers and individuals involved in the development of the biology curriculum:

- The biology curriculum should be regularly updated to keep pace with advancements in the fields of mathematics and science, emphasizing high-level thinking skills relevant to the contemporary age.
- In-depth evaluations, employing mixed research methods, can be conducted in collaboration with relevant stakeholders such as the Ministry of Education and universities, aiming to identify deficiencies in the biology curriculum and propose solutions.
- Analyzing biology teaching programs implemented in different countries can help identify shortcomings in our country's biology teaching programs, facilitating improvements.
- Researchers in the field can develop a biology teaching program that addresses the identified deficiencies, collaborating with curriculum development institutions.

In conclusion, this study has provided valuable insights into the perceptions of biology teachers regarding the 12th-grade biology curriculum. The findings highlight areas of concern, such as the suitability of achievements, teaching activities, and course content, while also recognizing the strengths of the curriculum in terms of alignment with prerequisite courses and the focus on developing students' thinking skills. Building upon previous studies on curriculum evaluation and drawing from international perspectives, it is crucial to consider the broader context of curriculum development. By incorporating best practices and lessons learned from both national and international experiences, we can further enhance the biology curriculum and ensure its relevance and effectiveness in preparing students for future challenges. It is important to emphasize the continuous improvement and updating of the curriculum to keep pace with scientific advancements and technological changes. This involves promoting critical thinking, interdisciplinary approaches, and practical application of knowledge. Collaboration among researchers, educators, policymakers, and curriculum developers is essential to create a dynamic and responsive biology curriculum that meets the needs of students in a rapidly evolving world.

Further research and evaluation studies are warranted to gather more comprehensive data on the effectiveness of the 12th-grade biology curriculum and identify areas for improvement. By integrating ongoing feedback and insights from biology teachers and other stakeholders, we can work towards creating an engaging, relevant, and student-centered curriculum that fosters a deep understanding and passion for the biological sciences. Ultimately, the goal is to provide students with a solid foundation in biology and equip them with the skills and knowledge needed to succeed in their

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academic pursuits and future careers. By continually evaluating and refining the biology curriculum, we can ensure that it remains a cornerstone of quality education, nurturing the next generation of scientists, researchers, and critical thinkers.

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