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Academic Performance of Rural Junior High School Students in Biology: Basis for Learning Activities Development

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Abstract

Biology education is crucial for living in a volatile, uncertain, complex, ambiguous, disruptive, and diverse environment. Moreover, most literature suggested developing learning activities for students based on the knowledge, attitudes, and skills competency gaps. Thus, this study assessed the academic performance in terms of their examination scores among the 150 randomly selected Grade Eight Biology students in different public schools in a rural municipality in Cebu, Philippines. It employed a descriptive research methodology. The test questionnaire was anchored on the Department of Education Learning Guide in determining the student's academic performance in Biology. The respondents' data were gathered from their Biology teachers and were expressed in frequencies and percentages. Data were computed using SPSS Statistics 27. The majority of the student's academic performance in Biology for Digestive System (n=65,43.33%), Biodiversity (n=68,45.33%), and Ecosystem (n=56,37.34%) competencies indicate that the majority of the respondents' scores did not meet expectations. Our findings strongly recommend that teachers carefully plan and provide necessary learning activities based on the needs and knowledge gaps of the students in their instructional practices to give their students a thorough grasp of the topics covered in the Biology class.

Keywords: Academic performance, biology, junior high school, learning activities.

Article Type:

Research article

Ethics Declaration:

This study followed all the rules stated to be followed within the "Higher Education Institutions Scientific Research and Publication Ethics Directive" scope. None of the actions specified under the title of "Actions Contrary to Scientific Research and Publication Ethics," which is the second part of the directive, were not carried out.

Ethics committee permission information

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Kırsal Bölge Ortaokulu Öğrencilerinin Biyoloji Akademik Performansı: Öğrenme Etkinlikleri Geliştirmenin Temelleri

Öz

Biyoloji eğitimi, değişken, belirsiz, karmaşık, muğlak, yıkıcı ve çeşitli bir ortamda yaşamak için çok önemlidir. Ayrıca, biyoloji eğitimi alanyazını bilgi, tutum ve beceri yeterlilik boşluklarına dayalı olarak öğrenciler için öğrenme aktiviteleri geliştirmeyi önermektedir. Bu nedenle, bu çalışma, Filipinler'in Cebu kentindeki kırsal bir belediyedeki farklı devlet okullarında rastgele seçilen 150 sekizinci sınıf biyoloji öğrencisi arasında sınav puanları açısından akademik performansı değerlendirdi. Çalışmada betimsel araştırma modeli kullanılmıştır. Öğrencinin biyolojideki akademik başarılarını belirlemek için Eğitim Bakanlığı Öğrenim Kılavuzu'na bağlı test kullanıldı. Çalışmanın verileri biyoloji öğretmenlerinden toplanmış ve frekans ve yüzde olarak ifade edilmiştir. Veriler SPSS Statistics 27 kullanılarak hesaplanmıştır. Öğrencinin akademik performansının çoğunluğu Sindirim Sistemi Biyolojisi (n=%65,43,33), Biyoçeşitlilik (n=%68,45,33) ve Ekosistem (n=%56,37,34) yeterliliklerinden oluşmaktadır. Cevaplayıcıların çoğunluğunun puanlarının beklentileri karşılamadığını göstermektedir. Çalışmanın sonuçları öğretmenlerin, öğrencilerine biyoloji dersinde işlenen konuların tam olarak kavranmasını sağlamak için öğretim uygulamalarında öğrencilerin ihtiyaçlarına ve bilgi boşluklarına dayalı olarak gerekli öğrenme aktivitelerini dikkatli bir şekilde planlamasını önermektedir.

Anahtar Kelimeler: Akademik başarı, biyoloji, lise, öğrenme etkinlikleri.

Introduction

Biology education has been integral to the curriculum from elementary school through college. The biology curriculum differentiates between the roles of Science and Technology in everyday human activities (Ogunkola & Clifford, 2013). Moreover, Biology education is crucial for success in today's Science and Technology-dominated global knowledge environment (Bell, 2013). Sadera et al. (2020) reaffirmed that education in the present world suffers heightened uncertainty due to globalization and technology's widespread and modern usage.

Biology is the scientific study of living organisms, and the biology curriculum covers many topics. Biology seeks understanding the mechanisms underpinning life and its diverse forms (Ambusaidi et al., 2021). Essential topics in biology include the structures and functions of cells and their components, genetics and inheritance, the systems of the human body, and biodiversity and ecosystems (Kaptan & Timurlenk, 2012). These topics are critical to understanding the natural world and how living organisms interact with each other and their environment.

Furthermore, one of the most important topics in biology is the systems of the human body. These systems include the respiratory, circulatory, nervous, and digestive systems. Understanding how these systems work together to sustain life is critical for medical professionals and scientists (Arrieta et al., 2020). Another crucial area of study is biodiversity and ecosystems, which encompasses studying the variety of life on Earth and the complex web of interactions between species and their environment (Adler, 1968). This topic is crucial for understanding the impact of human activities on the natural world and the importance of conservation efforts to protect biodiversity.

Biology is a crucial subject for a nation's growth and development. Hence, students' performance in this subject is regularly monitored in various countries (Bietenback, 2016). The biology students' knowledge and skills are vital for tackling the challenges of daily life (Merrill, 2002). Therefore, more attention is placed on the lessons that should be taught in Biology than any other subjects (Capuno et al., 2019; Perera, 2014). However, data from standardized national assessments indicate that students perform below expectations (Organisation for Economic Co-operation and Development [OECD], 2020). In recent years, this

underachievement in Biology is no longer limited to a few nations but has become a worry for every nation (van Merriënboer et al., 2002; Villarino, 2020). The Philippines is one of the nations with issues regarding high school Biology academic performance (Capuno et al., 2019; OECD, 2020).

Significant challenges such as a lack of educational materials and inadequate teacher preparation face Biology education (Villarino, 2020). In addition, the most pressing challenges in learning Biology are a lack of teachers, a lack of motivation among students, low self-confidence in learning Biology, a large number of students in each class, a lack of connection to other lessons, an inadequate number of laboratory equipment and facilities, and inadequate time allocation for Biology education despite an intensive curriculum (Kaptan & Timurlenk, 2012). With the introduction of Education 4.0, it is envisaged that students would also be digitally literate to learn Biology better (Orleans, 2007). This situation is unanimous from various studies (Baterna et al., 2020; Gormally et al., 2009), and these studies also find out the essentiality of the role of assessment in Biology teaching as teachers must give attention to the process and decisions regarding their teaching practices (Perera, 2014).

Though teacher training programs acquaint novice teachers with various assessment methods, there must be more time for those programs to permit teachers to improve their knowledge by utilizing these methods (Darling-Hammond, 2000). Also, novice teachers are usually evaluated by traditional methods. Subsequently, when teachers go into the classroom, they are met with innumerable responsibilities and challenges (Baker & Young, 2014). They may recourse to the methods they are accustomed to and those that are stress-free to use in their classroom discussion. Over time, teachers could create repetitive discussions, and they may be reluctant to modify their method of instruction (Bokan-Smith, 2015). Thus, awareness of fair assessment practices is not automatically translated to the proper assessment practices in real life (Baker & Young, 2014).

Based on the preceding situations, the present investigation addresses a critical gap. It was conceived to assess the academic performance of 150 Grade Eight Biology students in different public schools in a rural municipality in Cebu, Philippines, for the fourth grading examination in Biology as a basis for developing learning activities.

Method

The researchers utilized the descriptive method employing quantitative manipulation of data. The questionnaire method is the primary tool for gathering the data needed.

Respondents and Sampling Method

The respondents' data were gathered from their Biology teachers. The respondents were the Grade 8 students of three public high schools in a municipality in Cebu, Philippines. The randomization function of Microsoft Excel was used in the sampling. The total number of respondents was 150 using the Raosoft sample size calculator at a 5 percent margin of error and 95 percent confidence level.

Instruments

The test questionnaire was anchored on the Department of Education Learning Guide in determining the student's academic performance in Biology.

Data Gathering Procedure

In gathering the data needed, the researcher secured permission from the different school heads of the various public high schools in a municipality in Cebu, Philippines. The researcher personally retrieved the questionnaires. After the retrieval, the results were tabulated, computed, and interpreted to develop findings, conclusions, and recommendations.

Scoring Procedures

The scoring procedure for the 100 items test was based on the Assessment and Grading from the Memorandum of the Department of Education Order 31 series of 2020— Table 1 shows the grading scale and remarks.

Table 1.
The Grading Scale and Remarks

Grading scale	Remarks
90-100	Outstanding
85-89	Very Satisfactory
80-84	Satisfactory
75-79	Fairly Satisfactory
below 75	Did Not Meet Expectations

Data Analysis

The student's academic performance in their exam results in Biology was expressed in frequencies and percentages. The computations were performed using IBM SPSS Statistics 27.

Ethics Declaration

This study followed all the rules stated to be followed within the "Higher Education Institutions Scientific Research and Publication Ethics Directive" scope. None of the actions specified under the title of "Actions Contrary to Scientific Research and Publication Ethics," which is the second part of the directive, were not carried out.

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Results

The following tables present the students' Biology scores for each competency: Digestive System, Biodiversity, and Ecosystem.

Digestive System

This competency focused on the Digestive System's functions and structures. The digestive system was discussed on interacting with respiratory, circulatory, and excretory systems organs to supply the body with energy nutrients. The competency also looked into the breakdown of food as it undertakes physical and chemical changes. This topic also discussed the disease that can happen due to nutrient insufficiency, ingesting harmful elements, and their prevention and treatment. Table 2 shows the digestive system.

Table 2.
Digestive System

Grading Scale	f	%	Remarks
90-100	40	26.66	Outstanding
85-89	0	0	Very Satisfactory
80-84	28	18.67	Satisfactory
75-79	17	11.34	Fairly Satisfactory
below 75	65	43.33	Did Not Meet Expectations
Total	150	100.00	

For this competency, 40 (26.66%) of the students achieved an outstanding rating, 28 students (18.67%) achieved a satisfactory rating, 17 or 11.34% students earned a reasonably satisfactory rating, and 65 (43.33%) of the students a rating or did not meet expectations.

Biodiversity

This competency includes the idea of a species and categorization into a hierarchical taxonomic structure. Moreover, it also discussed conserving and protecting economically and endangered significant species. Table 3 shows the biodiversity system.

Table 3.
Biodiversity

Grading Scale	f	%	Remarks
90-100	34	22.67	Outstanding
85-89	8	5.33	Very Satisfactory
80-84	16	10.67	Satisfactory
75-79	24	16.00	Fairly Satisfactory
below 75	68	45.33	Did Not Meet Expectations
Total	150	100.00	

Thirty-four (22.67%) of the students achieved an outstanding rating, 8 (5.33%) of the students had a very satisfactory rating; 16 students, or 10.67%, achieved a satisfactory rating; 24, or 16% students got a reasonably satisfactory rating, and 68 or 45.33% of the students have achieved a rating of did not meet expectations.

Ecosystem

This competency is focused explicitly on the one-way movement of energy and the re-use of materials in the ecosystem: the oxygen-carbon, water, and nitrogen cycles. Moreover, the discussions were primarily centered on the effect of human actions on the ecosystem and the transmission of energy at trophic levels. Table 4 shows the ecosystem.

Table 4.
Ecosystem

Grading Scale	f	%	Remarks
90-100	41	27.33	Outstanding
85-89	11	7.33	Very Satisfactory
80-84	19	12.67	Satisfactory
75-79	23	15.33	Fairly Satisfactory
below 75	56	37.34	Did Not Meet Expectations
Total	150	100.00	

Forty-one (27.33%) of the students got an outstanding rating, 11 (7.33%) of the students achieved a very satisfactory rating, 19 students or 12.67% achieved a satisfactory rating, 23 (15.33%) students achieved a reasonably satisfactory rating, and 56 (37.34%) of the students had a rating of did not meet expectations.

Conclusion and Discussion

Our study assessed the academic performance of 150 grade eight biology students in different public schools in a rural municipality in Cebu, Philippines, for the fourth grading examination in Biology. The results in the Digestive System competency among the respondents have a rating of did not meet expectations. Knowing the different human systems in biology is essential because it allows us to understand how the human body works and how to diagnose and treat diseases that affect these systems (Merrill, 2002; Villarino et al., 2022). Medical professionals must deeply understand human systems to diagnose and treat their patients effectively (Ambusaidi et al., 2021). Additionally, studying the human systems can help us make informed choices about our health and lifestyle by understanding the impact of our choices on our bodies (Villarino, 2023; Villarino et al., 2022).

Moreover, the biodiversity competency got an overall rating of needed to meet expectations. Biodiversity is a crucial competency in biology class because it helps students understand the complex relationships between living organisms and their environment, the intrinsic value of biodiversity, and the importance of conservation efforts for human health and well-being (Villarino et al., 2021). Studying biodiversity in biology class allows students to recognize the critical role of ecosystems in regulating climate, water cycles, and air quality and

how they provide valuable medicines derived from natural sources (Cacciapaglia & van Woesik, 2016). Understanding biodiversity can help students appreciate the ethical considerations that arise when species are threatened with extinction and humans' role in preserving the natural world (Öztürk, 2003).

The results in the ecosystem competency got a majority rating of did not meet expectations. Ecosystems are essential in biology class because they help students understand the interdependence of living organisms and their environment, the importance of ecosystem services, and the consequences of ecosystem degradation and loss (Ambusaidi et al., 2021). The study of ecosystems in biology class informs students about the principles of ecology, the impact of human activities on ecosystem health, and the role of biodiversity in maintaining ecosystem resilience and also helps students make informed decisions about conservation and restoration efforts to protect and restore ecosystems (Bernard et al., in press; Hamann & Curio, 1999).

The findings in all competency areas indicate that most students achieved a grade of below 75. Thirty-seven to forty-five percent of the students needed to meet the expectations on the competencies. Meanwhile, twenty-two up to twenty-eight percent got a rating of outstanding on the competencies. Overall, the students had passed the three competencies with grades ranging from outstanding to reasonably satisfactory, which means that the students still performed well in their Biology subject despite the teachers' admission that they were not able to give an in-depth discussion with some biology topics and of not giving their best performance in class discussion due to paper works, forms to fill-up, lack of equipment, high ratio of teacher to students, and time constraints (Ambusaidi et al., 2021; Bybee, 1989; Öztürk, 2003).

Among junior high school students, biology education is significant as it provides a foundation for understanding the living world and developing critical thinking skills, scientific literacy, and an appreciation for the natural world (Adler, 1968; Ambusaidi et al., 2021). It also helps students understand their bodies, the environment, and the impact of human actions on the ecosystem, enabling them to make informed decisions about sustainability and conservation (Öztürk, 2003). Moreover, a strong foundation in biology can open up many opportunities for future careers in medicine, biotechnology, and environmental science (Adler, 1968; Bybee, 1989). Overall, biology education prepares students to pursue their interests and passions while making informed decisions about their health, the environment, and future careers (Ambusaidi et al., 2021).

Biology education is associated with teacher education and requires a comprehensive approach that prepares and supports future biology teachers to effectively teach the subject in K-12 classrooms (Antoniou et al., 2023). It involves developing a solid foundation in biological concepts, principles, theories, pedagogical skills, and strategies for teaching biology (Charitaki et al., 2022). This situation can be achieved through coursework on instructional methods, assessment and evaluation, classroom management, technology, and other instructional resources (Ambusaidi et al., 2021). Practical, hands-on experiences such as fieldwork, laboratory work, classroom observations, and practicum experiences are essential to apply knowledge and skills in real-world settings and developing the confidence and expertise needed to teach biology effectively (Vogiatzi et al., 2022).

In addition to preparing pre-service teachers, professional development opportunities for practicing biology teachers are critical to staying up-to-date with new research, teaching strategies, and emerging technologies (Vogiatzi et al., 2021). This situation includes attending conferences, workshops, online courses, and other forms of professional learning. Ultimately, effective biology teacher education must focus on preparing teachers who are well-versed in content knowledge and effective teaching strategies and committed to ongoing learning and development throughout their careers (Antoniou et al., 2023). By doing so, we can help ensure that future generations of students have access to high-quality biology education that prepares them for success in the modern world.

Furthermore, biology education is crucial in promoting inclusion and inclusive education in several ways. Firstly, it can provide opportunities for students to learn about the diversity of living organisms and ecosystems, fostering a sense of respect and appreciation for different life forms (Öztürk, 2003; Vogiatzi et al., 2022). Secondly, biology education can serve as a platform for addressing diversity and social justice issues, such as genetics, evolution, and environmental sustainability (Ambusaidi et al., 2021; Bybee, 1989).

Inclusive teaching practices can be integrated into biology education to ensure all students have equitable learning opportunities (Charitaki et al., 2022). By creating a safe and supportive learning environment, providing differentiated instruction and assessment, and using multiple teaching strategies to accommodate different learning styles, biology education can cater to the needs of all students, including those with disabilities and students from diverse cultural backgrounds (Vogiatzi et al., 2021). By promoting student-centered learning and empowering students to take an active role in their learning, biology education can help students develop the skills and confidence needed to be active and engaged members of their communities (Ambusaidi et al., 2021; Charitaki et al., 2022).

The current study used a limited sample size. It is necessary to replicate the findings using a larger sample size in future studies to enable a more comprehensive data collection and analysis and increase the generalizability of the results.

The findings and literature presented in this paper accentuate that Biology teachers should carefully plan and provide necessary learning activities to their instructional practices to give their students a thorough grasp of the topics covered in the Biology class. For future research, developing learning activities in Biology anchored on the needs and knowledge gaps of the students is recommended.

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Genişletilmiş Özet

Giriş

Biyoloji eğitimi, ilkokuldan üniversiteye kadar müfredatın ayrılmaz bir parçası olmuştur. Biyoloji müfredatı, bilim ve teknolojinin günlük insan faaliyetlerindeki rolleri arasında ayrım yapar (Ogunkola & Clifford, 2013). Ayrıca biyoloji eğitimi, günümüzün bilim ve teknoloji ağırlıklı küresel bilgi ortamında başarı için çok önemlidir (Bell, 2013). Sadera vd. (2020), günümüz dünyasında eğitimin küreselleşme ve teknolojinin yaygın ve modern kullanımı nedeniyle artan belirsizliğe maruz kaldığını yeniden doğruladı.

Biyoloji, canlı organizmaların bilimsel çalışmasıdır ve biyoloji müfredatı birçok konuyu kapsar. Biyoloji, yaşamı ve çeşitli biçimlerini destekleyen mekanizmaları anlamaya çalışır (Ambusaidi vd., 2021). Biyolojideki temel konular, hücrelerin ve bileşenlerinin yapılarını ve işlevlerini, genetiği ve kalıtımı, insan vücudunun sistemlerini ve biyoçeşitliliği ve ekosistemleri içerir (Kaptan & Timurlenk, 2012). Bu konular, doğal dünyayı ve canlı organizmaların birbirleriyle ve çevreleriyle nasıl etkileşime girdiğini anlamak için kritik öneme sahiptir.

Biyoloji eğitimi, eğitim materyallerinin eksikliği ve yetersiz öğretmen hazırlığı gibi önemli zorluklarla karşı karşıyadır (Villarino, 2020). Ek olarak, biyoloji öğrenmedeki en acil zorluklar, öğretmen eksikliği, öğrenciler arasında motivasyon eksikliği, biyoloji öğrenmede düşük özgüven, her sınıfta çok sayıda öğrenci, diğer derslerle bağlantı eksikliği, yetersiz laboratuvar araç ve gereçlerinin sayısı, yoğun müfredata rağmen biyoloji eğitimine ayrılan zamanın yetersiz olması (Kaptan ve Timurlenk, 2012). Eğitim 4.0'ın tanıtılmasıyla birlikte, öğrencilerin biyolojiyi daha iyi öğrenmek için dijital okuryazar olmaları da öngörülmektedir (Orleans, 2007). Bu durum çeşitli araştırmalarda hemfikirdir (Baterna vd., 2020; Gormally vd., 2009) ve bu çalışmalar da biyoloji öğretiminde değerlendirmenin rolünün gerekliliğini ortaya koymaktadır. Çünkü öğretmenler sürece ve ilgili kararlara dikkat etmelidir. Öğretim uygulamaları (Perera, 2014).

Öğretmen yetiştirme programları, acemi öğretmenlere çeşitli değerlendirme yöntemlerini tanıtsa da, bu programların öğretmenlerin bu yöntemleri kullanarak bilgilerini geliştirmelerine izin vermesi için daha fazla zaman olmalıdır (Darling-Hammond, 2000). Ayrıca, acemi öğretmenler genellikle geleneksel yöntemlerle değerlendirilir. Akabinde, öğretmenler sınıfa girdiklerinde sayısız sorumluluk ve zorlukla karşılaşırlar (Baker & Young, 2014). Alışık oldukları ve sınıf tartışmalarında kullanmak için stressiz olan yöntemlere başvurabilirler. Zamanla, öğretmenler tekrarlayan tartışmalar oluşturabilir ve öğretim yöntemlerini değiştirmek konusunda isteksiz olabilirler (Bokan-Smith, 2015). Bu nedenle, adil değerlendirme uygulamalarının farkındalığı, otomatik olarak gerçek hayatta uygun değerlendirme uygulamalarına çevrilmez (Baker & Young, 2014).

Önceki durumlara dayanarak, mevcut araştırma kritik bir boşluğu ele almaktadır. Filipinler'in Cebu kentindeki kırsal bir belediyedeki farklı devlet okullarındaki 150 sekizinci sınıf biyoloji öğrencisinin, öğrenme etkinliklerinin geliştirilmesine bir temel olarak biyolojideki dördüncü sınıf sınavı için akademik performansını değerlendirmek üzere tasarlanmıştır.

Yöntem

Çalışmada nicel araştırma yöntemlerinden olan betimsel yöntem kullanılmıştır. Anket yöntemi, ihtiyaç duyulan verileri toplamak için birincil araçtır. Katılımcıların verileri biyoloji öğretmenlerinden toplanmıştır. Ankete katılanlar, Filipinler'in Cebu kentindeki bir belediyedeki üç devlet lisesinin 8. sınıf öğrencilerinden oluşmuştur. Örneklemede Microsoft Excel'in randomizasyon fonksiyonu kullanılmıştır. Yüzde 5 hata payı ve yüzde 95 güven düzeyinde Raosoft örneklem büyüklüğü hesaplayıcı kullanılarak yanıt verenlerin toplam sayısı 150'dir. Çalışmada kullanılan anket, öğrencinin biyolojideki akademik performansını belirlemek için Eğitim Bakanlığı Öğrenim Kılavuzu ile ilişkilendirilmiştir. Araştırmacı, gerekli verileri toplarken Filipinler'in Cebu kentindeki bir belediyedeki çeşitli devlet liselerinin farklı okul müdürlerinden izin almıştır. Araştırmacı anketleri bizzat teslim almıştır. Erişimden sonra, bulgular, sonuçlar ve tavsiyeler geliştirmek için sonuçlar tablo haline getirilerek hesaplanıp yorumlanmıştır. 100 maddelik anket için puanlama prosedürü, 2020 tarihli Eğitim Bakanlığı Kararnamesi 31 serisinden değerlendirme ve notlandırmaya dayanmaktadır. Tablo 1, derecelendirme ölçeğini ve açıklamaları göstermektedir. Öğrencilerin biyoloji sınav sonuçlarındaki akademik performansları frekans ve yüzde olarak ifade edilmiştir. Hesaplamalar IBM SPSS Statistics 27 kullanılarak yapılmıştır.

Sonuç ve Tartışma

Çalışmada, Filipinler'in Cebu kentinin kırsal bir belediyesindeki farklı devlet okullarında bulunan 150 sekizinci sınıf biyoloji öğrencisinin biyolojideki dördüncü sınıf sınavı için akademik performansı değerlendirilmiştir. Ankete katılanlar arasında sindirim sistemi yetkinliği sonuçları beklentileri karşılamayan bir derecelendirmeye sahiptir. Biyolojide farklı insan sistemlerini bilmek önemlidir. Çünkü insan vücudunun nasıl çalıştığını ve bu sistemleri etkileyen hastalıkları nasıl teşhis edip tedavi edileceğinin anlaşılmasını sağlar (Merrill, 2002; Villarino ve diğerleri, 2022). Tıp uzmanları, hastalarını etkili bir şekilde teşhis ve tedavi etmek için insan sistemlerini derinlemesine anlamalıdır (Ambusaidi ve diğerleri, 2021). Ek olarak, insan sistemlerini incelemek, seçimlerin vücut üzerindeki etkisini anlayarak sağlığın ve yaşam tarzı hakkında bilinçli seçimler yapılmasına yardımcı olabilir (Villarino, 2023; Villarino ve diğerleri, 2022).

Mevcut çalışmada sınırlı bir örneklem büyüklüğü kullanmıştır. Daha kapsamlı bir veri toplama ve analizini mümkün kılmak ve sonuçların genellenebilirliğini artırmak için gelecekteki çalışmalarda daha büyük bir örneklem kullanarak bulguların tekrarlanması gerekmektedir. Bu makalede sunulan bulgular ve literatür, biyoloji öğretmenlerinin, öğrencilerine biyoloji dersinde işlenen konuları tam olarak kavramalarını sağlamak için öğretim uygulamalarında gerekli öğrenme etkinliklerini dikkatli bir şekilde planlamaları ve sağlamaları gerektiğini vurgulamaktadır. Gelecekteki araştırmalar için, öğrencilerin ihtiyaçlarına ve bilgi eksikliklerine bağlı olarak biyoloji alanında öğrenme aktivitelerinin geliştirilmesi tavsiye edilir.