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Neuromyths in Education

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Abstract

Despite a growing interest in the field of neuroeducation, it is widely accepted that attempts to establish interdisciplinary links between education and neuroscience can also lead to misunderstanding and miscommunication. Errors arising from misreading, misunderstanding or misquoting information about the brain and its functions are called neuromyths. Educational neuromyths, on the other hand, are defined as widely accepted erroneous beliefs that contribute to pseudo-scientific practices in educational settings, resulting from a misunderstanding of neuroscience. Neuromyths seen as a problem existing in educational environments for many reasons such as causing false truths in education and training, causing ineffective teaching, wasting important resources such as effort, time and money to be used for effective teaching practices, negatively affecting the reliability of the teaching profession and neuroscience research. For this reason, it is stated that neuromyths should be detected and eliminated. The purpose of this article is to give information about the causes of neuromyths, the importance of neuromyths in education, and how to eliminate neuromyths, by looking at neuromyths that cause problems in education from an educational point of view.

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Eğitimde Nöromitler

Öz

Nöroeğitim alanına giderek artan bir ilgi olmasına rağmen, eğitim ve nörobilim arasında disiplinler arası bağlantılar kurma girişimlerinin, yanlış anlama ve yanlış iletişime de neden olabileceği yaygın olarak kabul edilmektedir. Beyin ve işlevleri hakkındaki bilgilerin yanlış okunması, yanlış anlaşılması ya da yanlış alıntılanmasından kaynaklanan yanılgılara nöromit denir. Eğitsel nöromitler ise, eğitim ortamlarında sözde bilimsel uygulamalara katkıda bulunan, nörobilimin yanlış anlaşılması ile ortaya çıkan ve yaygın olarak kabul edilen hatalı inançlar olarak tanımlanmaktadır. Nöromitlerin, eğitim ve öğretimde yanlış doğrulara neden olma, etkisiz öğretime yol açma, etkili öğretim uygulamaları için kullanılacak çaba, zaman ve para gibi önemli kaynakların boşa harcanmasına neden olma, öğretmenlik mesleğinin ve nörobilim araştırmalarının güvenilirliğini olumsuz yönde etkileme gibi birçok nedenden dolayı eğitim ortamlarında var olmaları problem olarak görülmektedir. Bu nedenle nöromitlerin tespit edilmesi ve ortadan kaldırılması gerektiği belirtilmektedir. Bu makalenin amacı eğitimde var olmaları problem yaratan nöromitlere eğitsel açıdan bakarak, nöromitlerin sebepleri, nöromitlerin eğitimdeki önemi ve nöromitlerin nasıl giderileceği konuları hakkında bilgi vermektir.

Makale Bilgisi

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Introduction

Technological developments after 2000 have made neuroscience and neuroscience-related fields one of the fastest-growing areas of research (Simoes et al., 2022). Results from brain research have had a huge impact on areas such as marketing, architecture, management, and education (Grospietsch & Mayer, 2020). The Organization for Economic Co-operation and Development (OECD) started a project called "Learning Sciences and Brain Research" in 1999 aiming to bring together education and neuroscience experts and to increase awareness of neuroeducation by encouraging cooperation between these two fields (Çağıltay & Tunga, 2022). After this project, in the report titled "Understanding the Brain: Towards a New Science of Learning" published in 2002, the definition of neuromyth, which is still valid today, was made and emphasized that neuromyths spread rapidly among teachers (OECD, 2002).

The neuromyth (Torrijos-Muelas et al., 2021), which is not a new concept, emerged in the 1980s when neurosurgeon Alan Crockard used it to describe a misleading concept about brain function in medicine (Howard-Jones, 2014). With an educational approach, neuromyth is defined as a misconception that arises from misunderstanding, misreading, or misquoting scientifically proven facts during the use of brain research in education and other disciplines (OECD, 2002). Sullivan et al. (2021), defined educational neuromyths as widely accepted but incorrect or oversimplified ideas about neuroscience and learning, or as false beliefs about events, facts, and concepts about the brain and learning.

Çağıltay and Tunga (2022) made statements about "we use only 10% of our brain", "learning styles", and "right brain-left brain". They also stated that beliefs are educational neuromyths. Perhaps the most enduring and famous neuromyth using only 10% of the brain has been around for over a century (Papatzikis, 2017; Torrijos-Muelas et al., 2021). According to this ongoing belief that people use only 10% of their brains when people manage to use their brains with full performance, they will be able to easily do many things that they cannot do in the current situation (Aras et al., 2016).

The first of the three different possibilities in the OECD (2007) report on the origin of this myth is the famous scientist Albert Einstein, who was a guest on a radio interview in 1920 when he was asked about his intelligence and his statement that he only uses 10% of his brain. However, no record was found to confirm this explanation (Çağıltay & Tunga, 2022). The second possibility is that a researcher named Karl Lashley in the 1930s investigated the functions of brain regions by giving electric shocks to the brain and observed that many regions of the brain did not respond to the electric shocks. As a result of this experiment, he coined the term silent cortex and stated that the unresponsive regions of the brain do not have a function (Çağıltay & Tunga, 2022). Whereas the so-called 'silent' regions of the cerebral cortex belong to the associative cortex and have important functions for high-level psychological, psychosocial, and mental abilities (Bear et al., 2016). The third possibility is related to glial cells in the brain. It is stated that only 10% of the brain consists of neurons, the rest consists of dysfunctional glial cells, and the ratio of neurons to glial cells is 1:10 (Çağıltay & Tunga, 2022). However, the ratio of neurons and glial cells is actually about 1:1 (von Bartheld et al., 2016). Also, glial cells are not dysfunctional. They undertake important functions to support neurons and play a role in memory formation (Hilgetag & Barbas, 2009). This myth has long been confuted by the development of neuroimaging techniques (Çağıltay & Tunga, 2022).

Neuromyths, which are biased distortions of scientific truth, are often based on real scientific findings, although there are false claims about the brain (Papatzikis, 2017). An example of neuromyth, the misconception that learning outcomes can be improved if children are taught according to their own chosen learning style is based on valid research on how auditory, visual, and kinesthetic information is processed in different parts of the brain (Lethaby & Harries, 2015). However, these separate structures in the brain are highly interconnected. In addition, studies have shown that children do not process information more effectively when they learn according to their preferred learning styles (Coffield et al., 2004).

In the right brain-left brain neuromyth, it is claimed that logic is processed in the left hemisphere and creativity is processed in the right hemisphere. According to this neuromyth, the left hemisphere is responsible for intellectual, rational, verbal, and analytical thinking, and the right hemisphere is responsible for creative, intuitive, and non-verbal thought processes (Grospietsch & Mayer, 2020). The underlying fact of this neuromyth is that the brain contains two hemispheres that are not anatomically or functionally identical. The right-brain-left-brain neuromyth is based on this fact but leads to the erroneous conclusion that each hemisphere works separately and has a different function (Grospietsch & Mayer, 2019). However, scientifically, the two hemispheres are connected through the corpus callosum (Bloom & Hynd, 2005).

It is stated that schools and society in general give too much emphasis to the functioning of the left hemisphere of the brain, which unnecessarily forces this region of the brain. At this point, it is recommended to use both hemispheres of the brain equally and to facilitate the interaction between them (Grospietsch & Lins, 2021). Despite neuroeducation efforts aimed at uncovering the neural mechanisms of learning, neuromyths continue to exist widely (Fischer et al., 2010). Therefore, more studies are needed to detect and disprove educational neuromyths (Tunga & Çağıltay, 2021).

Causes of Neuromyths

Many people consider neuroscience and neuroimaging techniques to be the primary resources when it comes to the brain. Although education experts and researchers are interested in neuroeducation and neuroscience, they have difficulties in understanding and interpreting the findings due to the complexity of the imaging methods (MR, EEG, fMRI, etc.) used and the lack of field-specific knowledge required for interpreting the findings (Papatzikis, 2017). This situation reveals neuromyths that cause misinterpretation of neuroscience information on education and learning (Thomas et al., 2019).

Measuring teachers' neuroscience knowledge is important when transferring information from neuroscience to education because a lack of expertise can cause neuromyths to spread and be approved among educators (Dekker et al., 2012; Dündar & Gündüz, 2016). Neuromyths are based on scientific findings, but they are misinterpreted, exaggerated (Dündar & Gündüz, 2016), or oversimplified (Howard-Jones, 2014). At the same time, neuromyths can arise as a result of the overgeneralization of empirical research (Macdonald et al., 2017).

Some neuromyths can be formed through personal or social prejudices. Since neuroscience is one of the most complex and detailed scientific fields, it is often open to misunderstandings and false assumptions. When people try to discuss neuroscience in simple terms, they tend to oversimplify the brain's mechanisms of function and structure, which undermines both neuroscience and basic life knowledge (Papatzikis, 2017).

In addition, neuromyths can arise from many other reasons such as methodological differences between education and neuroscience, the inaccessibility of original research for financial reasons, the lack of experts and professional institutions to fill the gap between education and neuroscience, the publication of scientific evidence before it is ready, the ineffective and uninformed teacher training (Ansari & Coch, 2008; Goswami, 2006; Howard-Jones, 2014; Koschmeder, 2019; Papatzikis, 2017).

In sum, the general causes of neuromyths are given below:

- Complexity of neuroscience methods,
- Lack of domain-specific knowledge for the interpretation of neuroscience findings,
- Misinterpretation, exaggeration, generalization, and oversimplification of scientific facts,
- Personal or social prejudices,
- Methodological differences between education and neuroscience,
- Inability to reach the original sources due to economic reasons,
- Neuroeducation specialist deficiencies,
- Lack of professional institutions,
- Scientific sources published before they are ready,
- Ineffective and uninformed teacher training.

The Importance of Neuromyths in Education

As stated in the Organization for Economic Cooperation and Development Report and many different sources (Howard-Jones, 2014; Papatzikis, 2017; Thomas et al. 2019), the persistence of neuromyths leads to wasting of important resources such as time, money, and effort by using ineffective educational practices (Tunga & Cağıltay, 2021). In addition to the wasting money, time, and effort in education, this situation can also reduce educators' confidence in successful collaboration between neuroscience and educational disciplines (Pasquinelli, 2012; Sylvan & Christodoulou, 2010).

Educators' possession of neuromyths may also undermine the credibility of the teaching profession (Kim & Sankey, 2018) and neuroscience research (Zhang et al., 2019). Educators can weaken their authority by adopting practices compatible with neuromyths (Kim & Sankey, 2018). In addition, teachers who adopt practices based on a misunderstanding of scientific literature may lose confidence in neuroscience, undermining efforts to bridge the two fields (Zhang et al., 2019). Another issue is that the spread of neuromyths among educators is both costly and a major problem (Jansen, 2021). Since neuromyths can reduce the available resources required for research-supported practices such as supportive teaching by educators with limited time, money, and energy (van Dijk & Lane, 2018; Zhang et al., 2019). For example, misguided practices such as adapting teaching according to students' learning styles will negatively affect meaningful learning in the classroom (Kim & Sankey, 2018). These misapplications also waste the time spent on the effective professional development of teachers (Ferrero et al., 2016).

According to Koschmeder (2019), neuromyths in educators are directly related to student learning and development. Therefore, the global spread of neuromyths among educators is considered alarming and it is stated that they should be corrected because neuromyths can cause false truths in education and training (Koçak, 2020). For example, if an educator believes the neuromyth that dyslexia is caused by letter inversion, s/he may not be able to identify students with dyslexia but do not reverse letters, or appropriate services may not be provided (Macdonald et al., 2017). A teacher might believe the learning styles neuromyth and describe students as visual, auditory, or kinesthetic

learners. However, students' learning by using different sense organs will benefit them significantly (Rees et al., 2016). Patterson (2019) draws attention to the fact that educators with neuromyths can transfer these neuromyths to their students through teaching practices. Although some educators believe that this will not harm students, neuromyths about teaching and learning may prevent them from receiving the most appropriate and equitable education that all students deserve (Patterson, 2019). If teachers know what neuromyths are and how they are formed, they will be able to provide more effective teaching that can prevent the spread of neuromyths (Dubinsky et al., 2013; Hook & Farah, 2013).

In sum, the general consequences of neuromyths in education are given below:

- Wasting important resources such as time, money, and effort by using ineffective educational practices,
- Decreased confidence of educators in successful collaboration between neuroscience and education,
- As a result of teachers' loss of trust in neuroscience, efforts to build bridges between education and neuroscience are damaged,
- Damage to the credibility of the teaching profession and neuroscience research,
- Reducing available resources to be used for research-supported practices such as supportive teaching,
- Negative impact on meaningful learning in the classroom due to wrong practices,
- Decreased time for teachers to devote to effective professional development,
- The emergence of false truths in education and training,
- Allowing teachers to transfer their neuromyths to students,
- It is important because it will prevent situations such as not getting the most appropriate and equitable education that all students deserve.

How to Remove Neuromyths?

Interest in brain research is not enough to distinguish neuromyths from facts. Dialogue between neuroscientists and educators is very important for effective collaborations between neuroscience and educational disciplines (Hruby, 2012; Jolles al., 2005). It is thought that neuromyths will be prevented by increasing the communication between neuroscientists and educators and developing them through interdisciplinary dialogue (Rato et al., 2013). Another way to fix neuromyths is to educate and inform educators in academia and schools on how to address neuroscience and brain development more effectively. In addition, all these basic information about how the brain works should be presented to teachers and teacher candidates (Papatzikis, 2017).

Informing teachers about neuroscience can lead to the development of better teaching practices and a more critical awareness of neuromyths (Aldrich, 2013; Dündar & Gündüz, 2016). It has been determined that teachers and pre-service teachers who take courses or seminars on the brain and learning are more aware of neuromyths (Canbulat & Kırıktaş, 2017). Similarly, education is needed to reduce the prevalence of neuromyths in pre-service teachers (Dündar & Gündüz, 2016). McMahon et al. (2019), in their study, placed pre-service teachers in a trainee teacher program to determine and question the persistence of neuromyths in pre-service teachers. The results of the research revealed that the teacher candidates' belief in neuromyths decreased as a result of the program.

In short, there is a need to develop effective training for pre-service and in-service teachers in order to stop the spread of misinformation and direct resources to research-based teaching practices (Lethaby & Harries, 2015; Schwartz et al., 2019; van Dijk & Lane, 2018). Designing effective interventions can balance some neuromyth beliefs and their impact on teacher practice. However, before effective interventions can be developed, a better understanding of how educators think about the brain and how their beliefs affect their teaching practices is needed (van Dijk & Lane, 2018).

Detection of neuromyths is also very important in the process of eliminating neuromyths. Torrijos-Muelas et al. (2021) state that a guideline should be created in the literature to be used in the detection of neuromyths. Neuromyths will continue to be a problem unless standardized methods are developed to classify misconceptions about learning and the brain as neuromyths and to search for new neuromyths (Grospietsch & Lins, 2021).

In sum, it is recommended to do the following for the elimination of neuromyths:

- Increasing communication between neuroscientists and educators and improving it through interdisciplinary dialogue,
- More effectively educate and inform educators, both in academia and schools, on how to address neuroscience and brain development,
- Training pre-service teachers to reduce the prevalence of neuromyths,
- Designing effective interventions against neuromyths,
- A better understanding of how educators' thoughts about the brain affect their teaching practices,
- Establishing a guide to be used for the detection of neuromyths in the literature,
- Standardized methods for the classification and investigation of neuromyths need to be developed.

Discussion and Conclusion

Neuroeducation is an emerging field that draws attention to the potential practical implications of neuroscience research for education (Macdonald et al., 2017). This new field represents the intersection of cognitive and developmental sciences and education to develop evidence-based recommendations for teaching and learning (Fischer et al., 2010). Despite a growing interest in the field of neuroeducation (Cui & Zhang, 2021; Gola et al., 2022; Madua, 2022), it is widely accepted that attempts to establish interdisciplinary links between education and neuroscience can also lead to misunderstanding and miscommunication (Bowers, 2016; Bruer, 1997; Goswami, 2006).

Errors resulting from misreading, misunderstanding, or misquoting information about the brain and its functions are defined as neuromyths (OECD, 2002). The concept of neuromyth (Çağıltay & Tunga, 2022), which is formed by combining the words neuron (nerve cell) and myth, was used by the neurosurgeon Alan Crockard in the 1980s to describe scientifically incorrect beliefs about the brain in the medical literature (Howard-Jones, 2010). Educational neuromyths, on the other hand, are widely accepted erroneous beliefs based on a misunderstanding of neuroscience that contributes to pseudo-scientific practices in education (Ruhaak & Cook, 2018). Some of the most common neuromyths are that people use only 10 percent of their brains, that left-right brain dominance affects learning, and that individuals learn better when taught with their preferred learning style (Torrijos-Muelas et al., 2021).

There are different theories about how neuromyths arise (Carter, 2019). Neuromyths may arise as a result of a lack of scientific knowledge, communication gaps between scientists and teachers, and low-quality sources of information that teachers consult (Torrijos-Muelas et al., 2021). Over-generalization of scientific findings in educational settings (Bissessar & Youssef 2021), misinterpretation, exaggeration (Dündar & Gündüz, 2016) or oversimplification (Howard-Jones, 2014), personal or social prejudices (Papatzikis, 2017), popular media (Ruhaak & Cook, 2018), commercial interests (OECD, 2007), methodological differences between education and neuroscience (Howard-Jones, 2014), lack of neuroeducation experts and institutions (Ansari & Coch, 2006; Goswami, 2006), etc. can cause educational neuromyths.

Since the publication of the OECD (2002) report, educational neuromyths, and their potential problems have attracted the attention of researchers (Sullivan et al., 2021) and studies on neuromyths (Bissessar & Youssef 2021; Canbulat & Kırıktaş, 2017; Ching et al., 2020; Dekker et al., 2012; Dündar & Gündüz, 2016; Ferrero et al., 2016; Gleichgerrcht et al., 2015; Grospietsch & Lins 2021; Gülsün & Köseoğlu, 2020; Hughes, 2020; Karakuş et al., 2015; Macdonald et al., 2017; McMahon et al., 2019; Papadatou-Pastou et al., 2017; Pasquinelli, 2012; Rato et al., 2013; Ruhaak & Cook, 2018; Simoes et al., 2022; Torrijos- Muelas, et al., 2021). However, despite efforts to design evidence-based guidelines for neuroeducational practices and to leverage strong research findings on the neural mechanisms of learning, neuromyths remain widely available (Fischer et al., 2010). Despite the studies, it is stated that neuromyths exist and persist strongly in educational environments (Rousseau, 2021), among students, teachers, coaches, educators, and principals (Torrijos-Muelas et al., 2021).

Neuromyths can cause false truths in education and training (Koçak, 2020), lead to inappropriate and ineffective teaching (OECD, 2007), and waste resources such as effort, time and money that can be used for effective teaching practices (Dekker et al., 2012). Their existence in educational settings is considered problematic for many reasons, including the teaching profession (Kim & Sankey, 2018) and the reliability of neuroscience research (Zhang et al., 2019). Therefore, neuromyths should be detected and eliminated (Macdonald et al., 2017).

Since neuromyths are defined as over-generalizations (Macdonald et al., 2017) or oversimplifications of current neuroscience research, the first recommendation given by researchers to eliminate neuromyths is to disseminate neuroscience education (Çağıltay & Tunga, 2022; Dündar & Gündüz, 2016; Idrissi et al., 2020; McMahon et al., 2019; Papadatou-Pastou et al., 2017; Rousseau, 2021; Sarrasin et al., 2019). However, exposure to neuroscience training alone may not have a sufficient effect on neuromyths, as neuromyths are deeply rooted in personal belief systems (Grospietsch & Mayer, 2018). Given the evidence of success from studies and campaigns addressing neuromyths, a better understanding of why educators believe in neuromyths is needed (Herwegen et al., 2022).

Many researchers in the field draw attention to the potential benefits of bilateral collaborations between education and neuroscience disciplines for the elimination of neuromyths (Aldrich, 2013; Ansari & Coch, 2006; Dündar & Gündüz, 2016; Goswami, 2006; Herwegen et al., 2022; Howard-Jones, 2014; Hughes et al., 2020; Hruby, 2012; Jolles et al., 2005; Lethaby & Harries, 2015; Schwartz et al., 2019; van Dijk & Lane, 2018). In order to improve the transfer and translation of neuroscience, continuous collaboration should be developed between neuroscientists and educators by establishing a common language and common understanding (Bellert & Graham, 2013).

Neuroscience plays an important role in education, but how benefits can be realized without creating new neuromyths are among the topics discussed (Amiel & Tan, 2019; Thomas et al., 2019). Since misunderstanding neuroscience can lead to negative effects on students by extending to the adoption of non-evidence-based teaching practices, programs, or curriculum design (Hughes et al., 2020). Therefore, more research is needed to reveal whether neuromyths affect learning (Çağıltay & Tunga, 2022; Grospietsch & Lins, 2021; McMahon et al., 2019).

It is necessary to establish a standardized guide in the literature for the correct definition of neuromyths (Ruhaak & Cook, 2018), the detection of existing neuromyths, research and classification of new neuromyths (Gardner, 2020; Grospietsch & Lins, 2021; Torrijos-Muelas et al., 2021). Standardized methods are necessary to answer questions about the effectiveness of educational interventions, as well as large-scale studies and comparative studies (McMahon, 2019). Consequently, neuromyths will continue to be a problem if standardized methods are not developed (Grospietsch & Lins, 2021).

Contributions of the Researchers

All authors contributed to the manuscript equally.

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Conflict of Interest

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