

Summary

Misconceptions of the Learning and Teaching Process: Neuromyths and Their Formal and Informal Sources Introduction

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Misunderstanding, misinterpretation, and/or incomplete communication of scientific data in neuroscience are conceptualized as neuromyths (OECD, 2002). Although neuromyths arise from misinterpretation of the functions of the brain in the process of developing cognitive, metacognitive, and affective learning behaviors, they are usually based on actual scientific findings. Learning styles, one of the most common neuromyths, is a good example of this situation. In the learning process, visual, auditory, and kinesthetic stimuli are processed in different parts of the brain, leading to the belief that individuals have different learning characteristics. However, neuroscience research shows that the brain works holistically in the learning process and that there is a relationship between all of its structures, especially cognitive and metacognitive skills, working in conjunction with affective characteristics (Dekker et al., 2012). Neuromyths are generally examined in two sections, namely learning and brain function, and under various categorical structures. Similarly, some research has been conducted on neuromyths by enriching them with different items.

This research aimed to examine common neuromyths and formal and informal resources for the learning-teaching process based on existing research. In line with this purpose, answers to the following questions were sought:

1. How is the distribution of research on neuromyths according to years, countries, continents, disciplines, target group, and research methods?
2. What are the common neuromyths in the field of educational sciences?
3. What are the effects of formal and informal learning resources on the diffusion of neuromyths?

In the research, by conducting a comprehensive review of research on neuromyths, research gaps were identified, and the sources of common neuromyths were revealed. Neuromyths have many implications for the learning process. Therefore, it is of the utmost importance

to determine the neuromyths of educational stakeholders, especially in-service and pre-service teachers, about the developments in the field of neuroscience and to identify the sources that cause them to have these neuromyths. This study is expected to make a scholarly contribution to the investigation of intervention strategies for in-service and pre-service teacher education by increasing their consciousness, facilitating their comprehension of prevalent misunderstandings in educational settings, and aiding in the organization of their cognitive frameworks.

Methodology

Within the scope of the research, common neuromyths and their sources were analyzed by examining all studies on neuromyths in the field of educational sciences in the Web of Science (WoS) database with the systematic review method. The systematic review method is defined by Kitchenham (2004) as the analysis and evaluation of all studies relevant to the research questions or the related subject area with a review protocol. For this study, the review protocol consisted of four stages: planning, screening, selection, and synthesis. In the planning and screening phase, a descriptive review form was developed with regard to the purpose, methods, and outcomes of neuromyth research for the two research questions. For the purposes of the study, studies in the field of educational sciences, educational psychology, and neuroscience indexed in the Web of Science (WOS) database (SSCI, ESCI-SCI-E) were scanned with the keywords “neuromyths”, “neuromyths belief”, “neuromyths and learning” without any year limitation. Following the screening phase, 141 studies were reached in the first stage. In the selection phase, after publication bias, the language criterion (English), the criterion of being a research article (97), the criterion of education, neuroscience, and psychology field (62), the articles were re-classified according to their content

and a total of 49 articles related to the field of educational sciences and learning were selected. Subsequently, the articles were reclassified according to their content, and 37 selected articles were analyzed. In the synthesis phase, the selected studies were evaluated and discussed in terms of their theoretical foundations, aims, methods, and findings.

Findings

Findings related to the research question “How is the distribution of research on neuromyths according to years, countries and continents, disciplines, target group, and research method?”

An analysis of the distribution of studies on neuromyths by year revealed that the research on the subject commenced in 2012 and expanded between 2018 and 2020. This marginal interest in neuromyths started to decline after 2020. Despite the growing amount of studies on brain and mind research, the scarcity of investigations on neuromyths, in general, is quite notable. More than half of the studies on neuromyths were conducted in European countries. Among these countries, the UK was the most prominent country with seven studies. In terms of diversity target group and method, England stood out as the country where not only descriptive but also experimental studies were carried out in terms of method diversity, with studies targeting teachers, teacher candidates and lecturers. The European countries are followed by the Americas, particularly the United States of America with 26%, Asia with 11% and Australia with 9%. It should be noted that the distribution of countries on other continents is more limited, and with the highest prevalence is in European countries.

The analysis of the studies according to the disciplines showed that most of the studies were conducted in the field of education, followed by psychology, neuroscience and neuropsychology, medicine, and health sciences. The most remarkable factor in this distribution is that there are almost no interdisciplinary studies. The number of collaborative studies undertaken by specialists in the disciplines of education and neuroscience is quite restricted. The analysis of the target audience showed that the majority of the studies were conducted with teachers. This is followed by studies conducted with pre-service teachers. On the other hand, there is a limited number of studies for field experts, instructors, and students.

Looking at the methods of the studies, almost all of them are descriptive studies in the survey model and the data are collected using neuromyth questionnaires. There is one qualitative study with semi-structured interviews, four mixed studies, and three experimental studies. Of

the experimental studies, only one study aimed to measure the effect of the training program on neuromyths.

Findings related to the research question “What are the common neuromyths in the field of educational sciences?”

Learning styles are the most prominent among neuromyths. Although there is no scientific evidence that they are effective in the learning process, numerous neuromyths have been identified among teachers, prospective teachers, and other educational stakeholders participating in the research, including the following: learning styles; right and left brain dominance differentiate learning characteristics; mental capacity is hereditary and cannot be changed by environment and/or experiences; rich stimulating environments will better develop the minds of preschool children; brain functions stop during sleep; coordination exercises improve brain function; multiple intelligence applications.

Findings related to the research question “What are the effects of formal and informal learning resources on the diffusion of neuromyths?”

When examining the sources from which neuromyths are disseminated, formal and informal learning sources emerged as the most prominent. The formal sources that stand out in the dissemination of neuromyths are mainly in-service and pre-service training programs. Teacher training programs, in-service training seminars, scientific conferences and seminars, and professional development seminars organized by the public/private sector stand out among these sources. Both informal and formal sources are effective in the dissemination of neuromyths. Social media, other written and visual media tools, colleagues, peers or families, movies, and books stand out among these sources. The most important reason for the dissemination of approaches such as learning styles and multiple intelligences in formal settings is the diagnoses, classifications, and implementation activities have been carried out in this direction. Teachers endeavor to benefit from learning processes by paying attention to these approaches. Illustrative instances of such activities include lesson plans drawn from the multiple intelligence approach, which was previously widely implemented in Turkey, or diagnostics utilizing learning styles scales. In addition to formal sources, misconceptions about the function and capacity of the brain are strongly spread through informal sources.

Discussion

The study revealed the distribution of neuromyth-related research by year, region, study discipline, tar-

get audience, and methodology. Additionally, common neuromyths and their sources were attempted to identify. Within this framework, the study concluded that the volume of research initiated in 2012 surged in 2020 before subsequently declining. Despite the growing body of research on brain and mind research, the scarcity of studies is notably concerning. Looking at the distribution of studies by region, it was revealed that more than half of these studies were carried out in European countries, while studies on this subject are carried out all over the world. Notable is the fact that Turkey, which is included in the European Continent, only has three studies. It is surprising how very few studies there are on neuromyths in Turkey, one of the most populous countries in Europe in terms of students, teachers, and schools. Research on neuromyths has mostly been conducted with teachers and pre-service teachers. This fact demonstrates that the common neuromyth beliefs held by various educational stakeholders are indeed poorly identified. In particular, the fact that instructors engaged in teacher education contribute to the dissemination of neuromyths emphasizes the significance of conducting research centered on this specific population. On the other hand, it is also interesting that there are no studies on parents in the scans. Although studies on parents are limited in all studies of educational sciences due to the difficulty of the data collection process, the lack of research on parents' neuromyth beliefs is thought to be an important deficiency. Considering that parental influence is more dominant, especially in pre-school and early childhood, and that this influence continues into later periods, it is likely that erroneous schemas about learning and the function of the mind may have a significant impact on the guidance of children and their physical/psychological health.

The methodological analysis of the studies included in the research showed two significant issues that are evident. The first is that there is limited experimental research based on intervention programs; instead, all studies were focused on describing the existing situation. Another important shortcoming is that there is very limited data collection on the sources of neuromyths. Of all the studies, a very limited number of studies were designed to question the sources of neuromyths. In studies where the sources of participants' neuromyth beliefs are not questioned, it is not possible to develop effective intervention programs for these sources. Another important shortcoming of the studies is the very limited interpretations based on independent variables. For example, in studies conducted with teachers, differences in neuromyth beliefs based on variables such as seniority, gender, educational status, or educational level are not sufficiently questioned. Similarly, studies conducted with pre-service teachers do not adequately address the

variables such as program types, grade levels, types of courses taken, etc. All of these evaluations indicate that comprehensive descriptive research on neuromyths is still needed, and a wider stakeholder group's neuromyth beliefs should be established using various variables.

The studies reviewed in this review clearly show that there are widespread neuromyth beliefs among teachers, pre-service teachers, and other stakeholders in education. Recent research shows that neuromyths continue to be spread to the public from both formal and informal sources. Considering the field of educational sciences, this is really concerning. It is very important that teacher training programs, instructors, pre-service teachers, and teachers adopt evidence-based teaching approaches, develop their field and professional competencies, and support their educational practices with current scientific findings so that they do not contribute to the spread of neuromyths.

Neuromyths are spreading like a pandemic in the field of education. Mental schemas related to neuromyths are not easy to change. Since neuroscience is a specialized and complex field, it is also very difficult to transfer it to classroom practices (Deibl & Zumbach, 2023). The adaptation of neuroscience research findings to teaching-learning processes requires literacy skills in neuroscience as well as interdisciplinary studies between the fields of neuroscience, medicine and psychology, and educational sciences. It does not seem possible to change the mental schemas related to neuromyths only through seminars. Teacher training programs, diagnostic and intervention programs to be designed at the level of teachers and parents can change these false beliefs and raise awareness among educational stakeholders.