Title: Teachers' understanding of neuromyths: A role for educational neuroscience in teacher training.

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Introduction

Teachers in the UK must complete a degree and an Initial Teacher Training (ITT) programme to gain Qualified Teacher Status (QTS). Broadly these programmes train teachers to understand the curriculum, plan, structure and teach lessons, use assessment, and manage behaviour. In addition to teachers' existing knowledge and teaching skills, there is increasing evidence that an understanding of the brain systems and processes involved in learning can assist and influence teachers in developing optimal teaching practices (Howard-Jones, Jay and Galeano, 2020; Brick *et al.*, 2021), especially for children with Special Educational Needs (henceforth, SEN) (Thomas, Ansari and Knowland, 2019). Given the multiple cognitive processes involved in learning and evidence for how these relate to performance differences within and between different ages, it is understandable that teachers might be interested in learning more about this area of education in order to optimise their classroom practice (Tan and Amiel, 2022). However, there is no formal requirement for teachers to train in detail in cognitive learning processes, and ITT programmes provide very little taught content in this field (Blanchette Sarrasin, Riopel and Masson, 2019; Privitera, 2021).

Educational Neuroscience is a field of research aimed at understanding the interplay between cognitive systems and processes that underpin learning and education practice (Feiler and Stabio, 2018). Therefore, educational neuroscience could fill the gap in ITT programmes to provide teachers with the knowledge they require to understand these cognitive mechanisms. This is important because there is evidence that the current knowledge gap might be leaving teachers susceptible to belief in 'neuromyths' (Gini *et al.*, 2021) and applying unscientific teaching methods to their classroom (Tardif, Doudin and Meylan, 2015). Neuromyths are misconceptions and misunderstandings about the brain, such as '*humans only use 10% of the brain at any one time'*. Neuromyths have been discussed in educational neuroscience literature and have been found to be prevalent and persistent in various educational settings (Gini *et al.*, 2021). Believing in neuromyths and using such incorrect information in the classroom may have impacts on a student's learning. For instance, one of the highly endorsed educational neuromyths is of 'learning styles', which suggests that everyone has their dominant way of learning (i.e., verbal, auditory, kinaesthetic), and that lessons and materials should be designed and delivered accordingly. However, there is no evidence that individual learning styles exist (Rogowsky, Calhoun and Tallal, 2020). Furthermore, applying learning style to teaching practices can result in teachers and schools using budget, resources and time on activities that are not evidence-based, and these could be better spent on the development of more evidence-based approaches.

Debunking neuromyths through training in educational neuroscience might offer further benefits for practising teachers and teachers in training (Tardif, Doudin and Meylan, 2015) as it can enhance their understanding of evidence-based approaches to teaching and help them discern neuro-facts (i.e. evidence-based pedagogical recommendations stemming from educational neuroscience research) from neuromyths (Tokuhama-Espinosa, 2018). In addition, increasing the understanding of educational neuroscience in SEN teachers might specifically help them better understand the learning needs of children with neurodevelopmental disorders (Papadatou-Pastou, Haliou and Vlachos, 2017) and design teaching practice accordingly.

The current study aimed to understand the degree to which practising UK teachers believe in neuromyths and identify whether years of teaching practice and exposure to educational neuroscience training (if any) influence the extent of these beliefs. Such findings can inform ITT and discern whether there is a need for educational neuroscience training for teachers in the UK.

Specifically, the following research questions were addressed:

1. To what degree are teachers capable of differentiating neuromyths from neuro-facts?
2. What factors influence teachers' capacity to differentiate neuromyths from neuro-facts?

Current study

Participants: The study included teachers who are legally qualified to teach in the UK, and teachers who are completing the induction period for Early Career Teachers (ECT) at the time of data collection.

Materials: An online questionnaire was used to measure teachers' ability to differentiate neuromyths from neuro-facts. In addition, years of teaching and exposure to educational neuroscience training were measured. The core neuromythswere drawn from previous neuromyth studies (e.g., Macdonald *et al.*, 2017; Gini *et al.*, 2021). The neuro-facts were taken from established findings from educational neuroscience (e.g., Parvizi *et al.*, 2012; Centre for Educational Neuroscience, 2021). Eighteen neuromyths and eighteen neuro-facts were presented randomly to all participants. For all statements, participants were asked to what extent they agree or disagree with the statements on a 5-point scale (from *strongly agree* to *strongly disagree*).

Procedure: Full ethical approval was granted by the Host Institution Ethics Committee for the project in advance of the study**.** Informed consent was obtained from participants at the beginning of the online questionnaire.

Results

352 teachers completed the questionnaire (79% female). 123 had training related to SEN (e.g., certificate, diploma, CPD or degree); and 88 participants had completed some form of training in neuroscience/learning science. Overall, 187 participants reported using educational neuroscience-related materials in the classroom.

Neuromyths and neuro-facts were categorised into two groups: 1) general cognitive function (GCF); and 2) related to SEN. The neuromyths that were endorsed most frequently were: “writing letters backwards is a common symptom of dyslexia” (64%; m = 2.39, SD = .98) and “all children who are deaf and hard of hearing benefit from visual information” (70%; m = 2.15, SD = 1.05), which are both SEN-related neuromyths. The least endorsed neuromyth was “our brain stops developing by the time we reach our early teenage years” (5%; m = 4.24, SD = .93). The neuromyth “there is a link between children’s school performance and their preferred learning styles, such as visual, auditory or kinaesthetic learner” had the same endorsement and debunking percentages (44% endorsed, 44% disagreed; m = 3.07, SD = 1.5).

For each participant, neuromyths scores were subtracted from the evidence-based statements scores to calculate their ability to discern neuromyths from neuro-facts. This denoted their differentiation score, with higher scores indicating greater differentiation. The differentiation measure enabled examination of the teachers’ ability to differentiate evidence-based statements from neuromyths. Three further measures were used to predict a teacher's ability to differentiate neuromyths from neuro-facts. These were 1) years of teaching experience (YTE); 2) years of teaching experience with children with SEN (YTES); and 3) exposure to training in educational neuroscience.

Initial analysis indicated that there was no significant link between YTE and differentiation ($r = .047$, $p = .375$), and YTES and differentiation ($r = .086$, $p = .114$), and an ability to discern neuromyths from neuro-facts. However, teachers who had exposure to training in educational neuroscience were more likely to be able to identify which statements were correct and which were myths ($r = .201$, $p < .001$).

Implications and conclusion

The findings from this study suggest that acceptance of neuromyths is prevalent amongst teachers. Two of the most endorsed neuromyths were related to SEN. This is an important finding as it implies that teachers are still vulnerable to believing unscientific statements and teaching methods, and they likely use such methods in their classrooms when children have complex needs.

Importantly, teachers who had some exposure to educational neuroscience were better able to differentiate neuromyths from neuro-facts. This implies that better understanding of and engagement with the research evidence through educational neuroscience training might help teachers become less vulnerable to neuromyths and unscientific teaching methods. This is especially important in SEN contexts because the results of this study highlighted that, despite considerable experience teaching children with SEN, teachers were likely to not have received any training in educational neuroscience. This implies that teachers start their teaching careers without the knowledge to sufficiently teach SEN knowledge, and therefore they may not sufficiently understand the neural differences and related learning needs of these children. However, the benefits of understanding the neuroscience of learning goes beyond SEN teaching and administering specific interventions. If teachers are aware of neuroscientific concepts, they might apply this understanding and prevent poor pedagogical practice.

Based on the workload teachers currently have and high expectations of families, caregivers and schools, it is reasonable for passionate teachers to look for shortcuts for development. The results of this study suggest a need to ensure that teachers have the necessary skills to assess the veracity of interventions and statements about the brain. Formal and structured educational neuroscience training might provide teachers with this ability. It is suggested that such training be embedded in ITT and as part of continuing professional development.

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