

MISCONCEPTIONS ARE HARD TO DIE: UNDERSTANDING THE PREVALENCE OF MISCONCEPTIONS RELATED TO DIFFERENT LEARNING STYLES AMONG TEACHERS

EQUÍVOCOS CONCEITUAIS SÃO DIFÍCEIS DE MORRER: COMPREENSÃO DA PREVALÊNCIA DE CRENÇAS ERRÔNEAS RELACIONADAS AOS DIFERENTES ESTILOS DE APRENDIZAGEM ENTRE PROFESSORES

EQUÍVOCOS SON DIFÍCILES DE MORIR: COMPRENDER LA PREVALENCIA DE CREENCIAS ERRÓNEAS RELACIONADAS CON LOS DIFERENTES ESTILOS DE APRENDIZAJE ENTRE LOS PROFESORES



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ABSTRACT: Since their inception, Learning Styles (L.S) have gained popularity among teachers, researchers, and the public. However, these styles have been strongly criticized by researchers who claim that they lack evidence to support their effectiveness. Considering the above, I propose in this work to analyze the conceptualization compression as well as the means of identification of the Learning Styles of basic education teachers of science and biology in the Federal District. For this purpose, a questionnaire composed of open and closed questions was applied. The answers were analyzed by means of Textual Discourse Analysis. After analyzing the data, it was possible to observe that 60% of the teachers stated that they make use of the L.S in the classroom context. The main L.S observed were conceptualized within the visual-auditory framework, as well as the style proposed by David Kolb and Gardner's Multiple Intelligences.

KEYWORDS: Neuromites. Teaching science and biology. Basic education.

RESUMO: Desde a sua criação, os Estilos de Aprendizagem (E.A) ganharam popularidade entre professores, pesquisadores e o público em geral. No entanto, esses estilos têm sido fortemente criticados por pesquisadores que afirmam que eles carecem de evidências que apoiem sua eficácia. Considerando o exposto, proponho neste trabalho analisar a compressão da conceituação bem como os meios de identificação dos Estilos de Aprendizagem de professores da educação básica de ciências e biologia no Distrito Federal. Para esse propósito, foi aplicado um questionário composto por perguntas abertas e fechadas. As respostas foram analisadas por meio da Análise Textual Discursiva. Após análise dos dados, foi possível observar que 60% dos professores afirmaram que fazem uso dos E.A no contexto de sala de aula. Os principais E.A observados foram conceituados dentro da estrutura visual-auditivo, bem como o estilo proposto por David Kolb e as Inteligências Múltiplas de Gardner.

PALAVRAS-CHAVE: Neuromitos. Ensino de ciências e biologia. Educação básica.

RESUMEN: Desde su creación, los Estilos de Aprendizaje (E.A) han ganado popularidad entre profesores, investigadores y el público en general. Sin embargo, estos estilos han sido fuertemente criticados por investigadores que afirman que carecen de evidencia que respalde su eficacia. Considerando lo expuesto, propongo en este trabajo analizar la comprensión de la conceptualización, así como los medios de identificación de los Estilos de Aprendizaje de profesores de educación básica en ciencias y biología en el Distrito Federal. Para este propósito, se aplicó un cuestionario compuesto por preguntas abiertas y cerradas. Las respuestas fueron analizadas mediante Análisis Textual Discursivo. Después del análisis de los datos, se pudo observar que el 60% de los profesores afirmaron que hacen uso de los E.A en el contexto del aula. Los principales E.A observados se conceptualizaron dentro de la estructura visual-auditiva, así como el estilo propuesto por David Kolb y las Inteligencias Múltiples de Gardner.

PALABRAS CLAVE: Neuromitos. Enseñanza de ciencias y biología. Educación básica.

Introduction

Understanding the perceptions that teachers have about common misconceptions about the brain is of fundamental importance for the development and training actions of professionals dedicated to developing their critical consciousness. This has been one of the main reasons why several studies have focused on teachers' understanding of neuroscience (MCCUTCHEON *et al.*, 1993; DEKKER *et al.*, 2012; RATO *et al.*, 2013; DELIGIANNIDI; HOWARD-JONES, 2015; GLEICHGERRCHT *et al.*, 2015), including in Brazil (HERCULANO-HOUZEL, 2002). These authors demonstrated that teachers have a great interest in the use and application of neuroscience, but they know little about how the brain works, tending to believe in myths arising from it. Although these observations indicate a widespread belief in myths among teachers in several countries, the findings do not allow for generalization. For example, the British and Americans differed significantly in their endorsement of neuroscience misconceptions, while the British endorsed fewer misconceptions than Americans (MCCUTCHEON *et al.*, 1993).

One of these erroneous concepts believed by teachers has been “Learning Styles” (LE). “Learning Styles” emerged in the 1950s, gained popularity in the 1970s and are still a truism among educators (COFFIELD *et al.*, 2004). In total, there are more than 70 different EA systems (COFFIELD *et al.*, 2004), such as the “VAC” classification, which classifies individuals as “visual, auditory or kinesthetic” (GEAKE, 2008). The implicit assumption here is that information obtained through one sensory modality is processed in the brain to be learned independently of information obtained through another sensory modality.

The concept behind EA has some intuitive appeal and states that information through individually specific preferred teaching modalities can improve student learning by following three steps: (1) individuals will express a preference regarding their “Learning Style”, (2) individuals show differences in their ability to learn about certain types of information (e.g., some may be better at learning to discriminate sounds, while others may be better at discriminating images), and (3) the “correspondence” of instructional design to an individual's EA, as designated by one of the aforementioned classifications, will result in better results (e.g., visual learners should have information presented visually, while auditory learners would benefit better from an emphasis on audio).

However, there is much evidence from a multitude of modal investigations demonstrating that there is no empirical evidence to support the different EAs (GUDNASON, 2017; KIRSCHNER, 2017; NEWTON; MIAH, 2017; PASHLER *et al.*, 2009; POMERANCE

et al., 2016; SCOTT, 2010). EAs violate two of the main approaches to how the brain retains information. The first is multiple modalities, which argue that information can be stored longer for processing and encoding if it is presented in multiple formats, such as auditory and visual. The second is the dual coding theory, in which information is retained more effectively when it is presented in verbal and non-verbal formats (WININGER *et al.*, 2019).

With this lack of empirical evidence, it may be tempting to believe that the different types of EAs could be a harmless fad that will disappear on its own. After all, its popularity is at least partially rooted in the fact that it appeals to educators' egalitarian views about the universal capacity of students to learn if appropriate learning environments are constructed. However, there is reason to think that real harm can come from the application of EAs by teachers in classrooms. If teachers hold misconceptions, the scope of their negative influence can be enormous, impacting many students throughout their careers. Focusing on one sensory modality goes against the brain's natural interconnectivity (GEAKE, 2008).

Despite this widespread criticism, many teachers still believe in different types of EA. The Educational Endowment Foundation has argued that EA is not only an innocent misconception, but can be harmful by assigning students to groups or categories based on a supposed preference. If individuals are categorized according to EAs, there is a danger that this could lead to the assumption of fixed or rigid "styles", which could demotivate students from adapting, let alone seeking new challenges. Furthermore, the adoption of EA can limit the ways in which material is presented to certain students, leading to reduced opportunities to learn (COFFIELD *et al.*, 2004).

Learning Styles have, in fact, often been used in inappropriate ways by teachers, more as a way of classifying and labeling students, rather than a constructive way to enrich learning experiences (FRANKLIN, 2006). Furthermore, the complexity of learning can become simplified and trivialized.

One of the reasons EA has remained/remains rooted in education is that, at its most basic and general level, its claims are true. Any teacher knows that students differ from each other and that these particularities can make practical differences in how they learn. These differences, however, outside of a learning disability, tend to be small and representative of the student's stage of cognitive development rather than the categorization of a static Learning Style (AN; CARR, 2017). It seems likely, however, that well-intentioned teachers often notice these individual differences and fall victim to confirmation bias, looking for evidence in EA everywhere they look (RIENER; WILLINGHAM, 2010). What the literature on EA has done

is to take the reality that not all students are the same and build a “quasi-scientific” literature around it. In fact, an entire industry is built around the identification and quantification of such EAs (COFFIELD *et al.*, 2004).

Despite the lack of research to support the different EA and the potential harm it represents for students, it is possible to observe that the different “styles” are regularly present in textbooks and in teacher training (POMERANCE *et al.*, 2016; WININGER *et al.*, 2019) as well as in higher education (NEWTON, 2015; NEWTON; MIAH, 2017). Intuitively, there are many attractive things about the concept of Learning Styles. Students are obviously different, and EAs seem to offer teachers a way to accommodate individual differences. This intuitive attraction can lead teachers toward misconceptions. Therefore, considering the above, I propose in this work to analyze the compression of the conceptualization as well as the means of identifying the Learning Styles of teachers of basic Science and Biology education in the Federal District.

Materials and methods

This is a cross-sectional study carried out with science and biology teachers, working in basic education in the Federal District, Brazil. Participation in this study was deliberate according to the choices and wishes of each participant. The invitation to participate in this study was sent via social media to teachers by the Federal District Education Department working in basic education. Participation was voluntary; All participants who agreed to participate in the work were asked to sign an informed consent form.

The collection tool used in this study was a research design inspired by Papadatou-Pastou *et al.* (2021). For this purpose, a questionnaire administered in digital format was adopted. The questionnaire presented questions about demographic data (gender, age, education and teaching experience), closed questions (Do you know/understand what learning styles are? With answer options: “understanding”, “I don’t understand”, “No I know” or “I do not wish to answer”; if the answer was yes, the next question will be: Where did you learn about this Learning Style? With answer options including: “through school”, “at university”, “colleagues”, “social media”, “books”, “scientific articles” or “others”, and closed questions on a six-point Likert scale, ranging from “totally disagree” to “totally agree”.

Although the questionnaire forces participants to take a position on an issue about which they may be misinformed, it was assumed that the vast majority of teachers would be familiar

enough with EA to respond. Each of the Likert scale questions aims to measure a distinct manifestation of EA (the questions are: Do students learn best when information is presented to them in their individualized learning style? Differentiating instruction based on students' individual Learning Styles is an essential part of effective teaching? Is assessing students for their individual Learning Style an essential part of effective teaching? Differentiating teaching based on students' individual Learning Styles is fundamental to the teaching and learning process in the classroom Is differentiating the teaching process based on each student's Learning Styles a sound, research-based educational practice? Do I personally identify with a specific learning style?).

Open questions were also included (How many learning styles do you know and what are they? Do you use learning styles in your classroom/teaching? If so, in what ways? Give examples. Do you think students learn better when they receive information in their own learning style? Give examples. Do you think students show a preference for the way they learn? If so, in what ways? Give examples. How do you recognize each student's learning style?).

Data analysis was carried out following a “top-down” approach. Quantitative data were analyzed using a statistical program (Statistical Package for the Social Sciences – SPSS v25). Descriptive statistics were tabulated and expressed as a percentage. To examine differences in mean ratings of sociodemographic variables were analyzed using a separate independent t-test. Statistical significance was determined using a p value of 0.05. To analyze the qualitative data, discursive textual analysis (DTA) was used, following the principle that this analysis can be used with deductive and inductive methodologies (MORAES; GALIAZZI, 2006). ATD is determined by a process of textual self-organization in the construction of understanding in which new understandings emerge from three sequential components: (i) unitarization; (ii) categorization; and (iii) emerging capture (MORAES; GALIAZZI, 2006).

Results and discussions

120 teachers participated in this study, with experience in different teaching modalities (Table 1). It is worth noting that the same teacher can work in more than one modality. Among the teachers; 73.3% (n. 88) mentioned having completed a specialization in the area of Science Teaching and 16.7% (n. 20) mentioned being studying some type of specialization in the area of education. Teachers comfortably responded to our questions about Learning Styles, as

indicated by the absence of unanswered cases, as well as the richness of the responses, suggesting a familiarity with the term.

Table 1 – Teachers' demographic data (N = 120)

	Female (n=80)	%	Male (n=40)	%
Age	12	10.0	4	3.3
25-30	24	20.0	8	6.7
31-36	24	20.0	4	3.3
37-42	20	16.7	24	20.0
> 43	12	10.0	4	3.3
Teaching Modality				
Elementary School	80	66.7	12	10.0
High school	56	46.7	40	33.3
Teaching Young People and Adults	80	66.7	4	3.3
University education	12	10.0	0	0
Teaching Time				
1 to 3	8	6.7	0	0.0
4 to 6	8	6.7	8	6.7
7 to 9	4	3.3	0	0.0
10 to 12	16	13.3	8	6.7
13 to 15	16	13.3	4	3.3
> 15	28	23.3	20	16.7

Source: Prepared by the author

It was possible to observe that 53.3% (n. 64) of the 120 teachers reported a belief that students learn better when they receive information in their preferred Learning Style, 26.7% (n. 32) mentioned not understanding what they are EA and 20% (n. 24) did not want to comment. It was not possible to observe significant differences between the teachers' age, teaching modality, gender and teaching time with EA beliefs using the t test applied.

The prevalence of the Learning Styles myth was particularly high, which is in line with the literature in different countries (e.g. DEKKER *et al.*, 2012; DÜNDAR; GÜNDÜZ, 2016; TARDIF *et al.*, 2015). When asked where they learned about EA: 23.3% (n. 28) of teachers mentioned having learned it at University, 16.7% (n. 20) mentioned having learned it at school, 6.7% (n. 8) learned it through scientific articles and 53.3% (n. 64) through other sources of information.

The high incidence of statements in which teachers mention having learned at university or even at school is in line with what Coffield *et al.* (2004) reported in their work. These authors observed that there are numerous for-profit organizations that develop assessments for different Learning Styles, which are disseminated in Higher Education Institutions. This also includes

organizations that develop and provide tools for teachers to use in the basic education classroom.

Considering scientific dissemination material (scientific article), Newton (2015) found that the overwhelming majority (89%) of research works between July 23, 2013 and July 23, 2015, present in the ERIC research databases and PubMed, implicitly or directly endorsed the use of Learning Styles in higher education. In addition, Olsen *et al.* (2022), carrying out a systematic review of scientific articles related to Learning Styles, observed that, during the years analyzed (2009-2019), different from what was expected, there was a tendency for an increase in literature supporting these styles in all teaching modalities .

Despite teachers' familiarity with the term, however, it did not translate into a uniform view of EA. This is not to say that there were no patterns in their responses. With regard to teachers' understanding of EA, it was possible to code the answers for those with reference to literature and for those of common sense. The codes assigned to the categories were those found in the literature on known EAs (COFFIELD *et al.*, 2004; PASHLER *et al.*, 2009), theories and learning approaches (TABLE 1). As can be seen, the answers referring to the Learning Styles taxonomies were mostly extracted from the VAC modalities.

Table 1 – Learning Style Categories in teachers' perception

	CATEGORY	EXAMPLE	n.	%
Learning Style Taxonomy	VAC	visual, audio or visual, audio, kinesthetic	56	46.7
	KOLB	concrete experience (act), reflective observation (reflect), abstract conceptualization (conceptualize) and Active experimentation (apply).	12	10.0
	Multiple Intelligences	linguistic, musical, kinesthetic, naturalistic, spatial, visual, practical, intrapersonal, interpersonal	8	6.7
Learning Theories	Informed by combinations of any of the learning theories	cognitive, constructivism, behaviorism	8	6.7
Common sense	-----	Use of media	8	6.7
Did not declare	-----	-----	28	23.2

Source: Prepared by the author

In fact, it was possible to observe a good number of responses indicating that teachers conceptualize and understand EA mainly within the structure of the modalities: Visual-Auditory-Kinesthetic (FLEMING; BAUME, 2006), followed by the KOLB method (KOLB, 1984, 1985) and Gardner's Theory of Multiple Intelligences (1983).

The VAC Learning Style states that students can learn better if they receive information according to their preference, which can be visual, auditory or kinesthetic (FLEMING; BAUME, 2006). There is no evidence, however, to prove this theory (PASHLER *et al.*, 2009; NEWTON, 2015). Furthermore, areas of the brain do not work in isolation, so there is no way to predict that one sensory channel will work without the participation of the other in information processing (PASHLER *et al.*, 2009).

The EA proposed by David Kolb (1984, 1985) conceives individuals' learning processes as different in two dimensions: preferred mode of perception (concrete to abstract) and preferred mode of processing (active experimentation to reflective observations). This EA classifies individuals into four types based on their position along these two dimensions: divergent (concrete, reflective), assimilators (abstract, reflective), convergent (abstract, active), and accommodators (concrete, active). Trying to validate this process, Cook *et al.* (2009) analyzed whether the use of this EA would provide better performance in medical residents. However, these authors found no evidence to support this claim. There was no association between dimensions or format preference with resident performance. As in other studies, it was possible to observe that this Learning Style does not influence educational results (COOK *et al.*, 2006, 2007).

The Theory of Multiple Intelligences postulates that each individual has, at their disposal, an intellectual profile of eight intelligences (GARDNER, 1983). Gardner proposes that “the Theory of Multiple Intelligences pluralizes the traditional concept” (GARDNER, 1995, p. 15), defining intelligence as a “biopsychological potential of intellectual faculties. The theory itself is not a neuromyth, but its use in education can be considered. Sometimes, it is possible to observe a tendency for lay people and even teachers to confuse “mind” and “brain” (GARDNER, 2020). Brain refers to the tissue within the skull, while mind is a construct invoked by psychologists to refer to cognition, personality, emotions, will, and the like, each of which is a construct that Gardner posits. “Brain” should be invoked only when there is direct evidence obtained from studies of the nervous system; and yet the terms “neuro” or “brain” are routinely invoked even when the evidence is purely psychological, or even anecdotal (GARDNER, 2020).

The potential for multiple interpretations of Learning Styles by teachers is also recognized by other authors (e.g. MOREHEAD *et al.*, 2016), and some studies highlight a lack of clarity regarding the specific meaning of Learning Styles (PAPADATOU-PASTOU *et al.*,

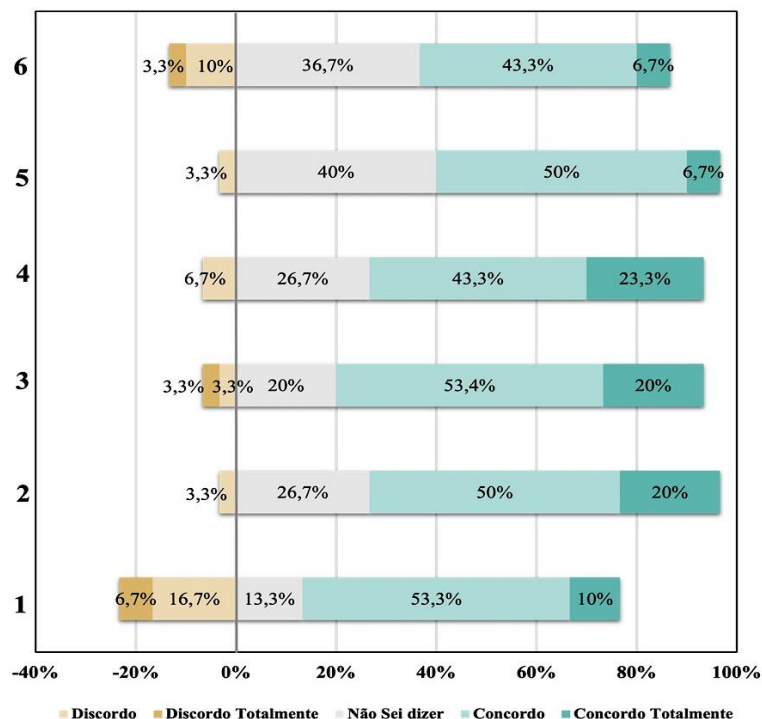
2021). It is worth noting that there is no evidence to support the use of Learning Styles in teaching and learning processes (COFFIELD *et al.*, 2004; PASHLER *et al.*, 2009).

Considering Kunter *et al.* (2013), science and biology teachers need to present valid theoretical knowledge about the curricular content regarding the nervous system. Teachers are also expected to present pedagogical and psychological knowledge about the psychology of human learning and pedagogical content knowledge about instructional strategies for learning processes. Overall, the results observed by teachers expose the importance of integrating neuroscientific content in Teacher Training, as was similarly observed by Papadatou-Pastou *et al.* (2017). Given the above, we agree with other works (CLARK; FELDON, 2005; MERRILL, 2002) that, instead of trying to use Learning Styles to adapt the teaching and learning process, the teacher's effort would be better spent if the use of more effectiveness of already established instructional methods to work on a given learning objective.

When asked about the use of EAs in the classroom, 60% (n. 72) stated that they use them in the classroom context, 16.7% (n. 20) said they do not use them and 23.3% (n. 28) were unable to identify whether they use EAs. Among those who do use them, the most commonly reported answers were the VAC classification (mentioned previously). Teachers variously referred to practices that incorporate audiovisual resources ranging from photos, videos, communication technologies and interactive whiteboards.

Considering Learning Styles, teachers were asked to respond to the level of agreement related to some statements (Figure 1). It is worth noting that all statements are classified as neuromyths. As can be seen, the level of agreement for the statements presented was higher than the level of disagreement.

Figure 1 – Teachers’ beliefs about learning styles



Note: 1) Do students learn better when information is presented to them in their individualized learning style? 2) Is differentiating teaching based on students’ individual Learning Styles an essential part of effective teaching? 3) Is assessing students for their individual Learning Style an essential part of effective teaching? 4) Is differentiating teaching based on students’ individual Learning Styles fundamental to the teaching and learning process in the classroom? 5) Differentiating the teaching process based on each student's Learning Styles is a sound, research-based educational practice and 6) Do I personally identify with a specific learning style?).

Source: Prepared by the author

The answers to the statements presented about the teachers' beliefs aligned perfectly with the way they referred to and conceptualized EA, as well as identifying them in their practice. In addition, it is possible to infer the possible impact of this use on teaching practice, indicating that their beliefs about Learning Styles influence their teaching process. Data from our sample, along with a growing body of research, have shown that teachers' underlying beliefs about learning are no exception (RATO *et al.*, 2011; DEKKER *et al.*, 2012; PAPADATOU-PASTOU *et al.*, 2021).

When asked about the approaches by which teachers identify their students' EA, it was possible to observe 5 (five) categories (Table 2). These categories mainly involved some informal means, such as observing (how and what) and communicating with students, but also some typical assessment methods. The most prevalent responses were those involving direct observation of students' behavior (48%, n. 55).

Table 2 – How teachers declare to identify Student Learning Styles

Means of identifying Learning Styles			
Categories	Explanation	n.	%
Observing how the student:	behave when I teach a class; respond to techniques and practices in the classroom; learn/process; remember/assimilate; describe how you solve problems; collaborate and interact; to participate; to communicate	55	45.8
Observing what the student:	interests or motivates; presents as preferences; the progress they make; time they need; annoys; presents as his inclinations; search; its potential; attracts your attention	23	19.2
Means of measurement and evaluation	Participation; exercises; tasks.	32	26.7
Communicating	Communication and dialogue; daily contact; exploratory questions; involvement and discussion; student record – statements.	6	5.0
Can't identify		4	3.3

Source: Prepared by the author

We emphasize that, as teachers present a detailed account of the methods, they have to identify students' EA and the beliefs they have about these styles, it is possible to say that this myth still remains in basic education in Brasília. It is worth noting that the continued use of Learning Styles is, in theory, associated with a series of harms in education (PASHLER *et al.*, 2009; RIENER; WILLINGHAM, 2010; DEKKER *et al.*, 2012; ROHRER; PASHLER, 2012; DANDY; BENDERSKY, 2014; WILLINGHAM *et al.*, 2015). These authors mention a classification of students according to invalid criteria, for example, a “visual” student may be deterred from seeking information that does not seem to correspond to their EA and/or may become overly confident in their ability to master subjects perceived as corresponding to their EA (NEWTON; MIAH, 2017). In this sense, we reiterate the importance of teacher training as an alternative to provide appropriate evidence-based strategies that can replace EA (PAPADATOU-PASTOU *et al.*, 2021).

The belief in EA neuromyths can be considered problematic, on the one hand, because it can lead teachers to pass on incorrect cognitive psychology/neuroscience content and/or ineffective learning strategies to their students. On the other hand, the “money, time and effort” of the educational system can be wasted and teachers and students are deprived of the opportunity to spend these resources on more effective theories and methods (GROSPIETSCH; MAYER, 2020).

Final remarks

In conclusion, this is the first study to empirically investigate how Learning Styles are conceptualized, identified and applied in the classroom by Science and Biology teachers in Brasília. The data clearly shows that the concept of EA is understood differently by teachers. It was also possible to observe that teachers identify students' EA in different ways. Furthermore, our results show that the teacher uses EA in the classroom, being presented in different ways. This level of variability in responses presents a lack of consensus between what EA actually comprises and how it should be identified. Therefore, we consider that this work, combined with the literature on the subject, can be a starting point for professionals who work with Initial Teacher Training to develop appropriate practices to identify misconceptions regarding EA, while at the same time providing alternatives based on evidence.

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